Building 1/36 Area (Parcel C) Source-Area Groundwater *In-Situ* Reactive Zone Pilot Study Workplan

Boeing Realty Corporation, Former C-6 Facility, Los Angeles, California

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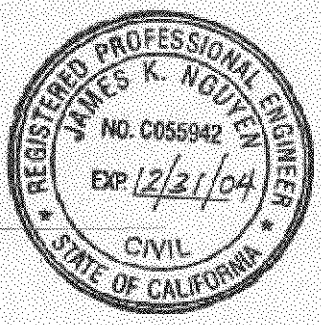

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1. Introduction/Background

Soil and groundwater have been investigated in Parcel C at the Former Boeing C-6 Facility (Site) located at 19503 South Normandie Avenue in Los Angeles, California (Figure 1). Parcel C is approximately 70 acres. Previous investigations have shown the presence of volatile organic compounds (VOCs) in soil and groundwater at certain areas of the Site that require remediation.

Several remedial approaches were evaluated for addressing VOC-impacted groundwater. Based on the detailed evaluation of substantial groundwater quality monitoring data, enhanced biodegradation was selected as the most feasible alternative to remediate the source-area VOCs in the shortest time. This workplan presents an overview of the Site characteristics and the details of a Parcel C source-area groundwater pilot study plan to use enhanced biodegradation for the remediation of VOCs in groundwater.

1.1 Site Hydrogeology

The Site is underlain by the Bellflower Aquitard, which is a regional hydrogeologic feature in the Los Angeles basin. Vadose zone soils at the Site consist predominantly of silts, clays, and fine-grained sands, which are highly heterogeneous across the Site and are impacted in certain areas with VOCs. The primary VOCs found in soil include trichloroethylene (TCE), 1,1-dichloroethene (1,1-DCE), and 1,1,1-trichloroethane (1,1,1-TCA). Groundwater at the Site occurs at a depth of approximately 60 to 65 feet below ground surface (bgs) under unconfined conditions and flows generally to the south. The water-bearing zone consists of two primary units, the Middle Bellflower Sand, which is the water-bearing unit, and the Lower Bellflower Aquitard, which separates the Middle Bellflower sand from the underlying Gage Aquifer. The Middle Bellflower sand extends to a depth of approximately 115 feet bgs and consists of three sub-units; the B-Sand, the Middle Bellflower Mud (MBFM), and the C-Sand. The B-Sand is present from approximately 65 to 85 feet bgs and consists predominantly of a fine to medium sand. The MBFM is a silt and clay layer that is present from approximately 85 to 95 feet bgs and appears to be present across much of the Site. The C-Sand is present from approximately 95 to 115 feet bgs and consists predominantly of a fine to medium sand. Groundwater at the Site has a relatively flat gradient (0.001 feet/foot) and flows predominantly to the south at a rate of approximately 10 to 20 feet per year.

1.2 Site Groundwater Quality

Groundwater quality has been characterized with data from 43 monitoring wells and 45 multi-depth Simulprobe borings installed at strategic locations across the Site. Monitoring wells are generally screened within the top 20 feet of the groundwater. Simulprobe sampling was performed to evaluate the vertical distribution of VOCs in the B-Sand and the C-Sand. Since VOCs appear to be stratified in the B-Sand, it is divided further into two sub-units, the Upper B-Sand and Lower B-Sand. (The MBFM is present within what will be described going forward as the lower B-Sand and the C-Sand. It varies from North to South throughout the source area plume.)

Source-area groundwater consists of the impacted groundwater with the highest concentrations of VOCs at the Site. Two primary groundwater source-areas have been identified in Parcel C and are located in the former Building 1/36 and Building 2 locations. The former Building 1/36 source-area is the primary focus of this workplan.

The primary impacts in the Building 1/36 source area are TCE and 1,1-DCE. Figures 2 and 3 illustrate the site-wide groundwater impacts (January 2001) for TCE and 1,1-DCE, respectively. These compounds constitute the most elevated concentrations and largest areal impacts. Other compounds are present within these plumes, however, they cover a smaller aerial extent. Other compounds present at elevated concentrations include 1,1,1-TCA, toluene, methyl ethyl ketone (MEK), and acetone. 1,1,1-TCA will degrade abiotically to 1,1-DCE and acetate; toluene, MEK and acetone will undergo direct biodegradation. As a result, TCE and 1,1-DCE are the primary focus of this enhanced source-area biodegradation program.

Given the stratified nature of the Bellflower aquiclude, the distribution of TCE, 1,1-DCE, and other elevated VOCs is summarized below.

- Upper B-Sand: TCE and 1,1-DCE source area plumes overlap 1,1,1-TCA, toluene, MEK, and acetone plumes of comparable concentrations. The areal extent of the TCE and 1,1-DCE plumes dominate.

- Lower B-Sand: TCE, 1,1-DCE, and 1,1,1-TCA source area plumes overlap toluene and MEK plumes of comparable concentrations. The areal extent of TCE, 1,1-DCE, and 1,1,1-TCA plumes dominate.

- C-Sand: 1,1-DCE and 1,1,1-TCA source area plumes overlap toluene and MEK plumes of comparable concentrations.

1.3 Site Groundwater Biogeochemistry

A baseline sampling standard operating procedure was developed and implemented for select biogeochemical parameters in groundwater to evaluate natural biodegradation processes at the Site (England-Geosystem/Haley & Aldrich, 2001). Based upon the data collected for the baseline biogeochemical program, groundwater in the Building 1/36 area is anaerobic (dissolved oxygen [DO]< 1.0 milligrams per liter [mg/L]) and has negative redox conditions (oxidation reduction potential [ORP] less than −50 mV). Moderate nitrate and sulfate depletion, elevated dissolved iron, and trace amounts of methane have also been observed in the Building 1/36 area, and toluene and other potential electron donors (e.g., MEK) are present. Because of the presence of electron donors, conditions in the Building 1/36 area are already anaerobic, reducing, and are considered favorable for the reductive dechlorination of compounds such as TCE, cis-1,2-DCE ,1,1-DCE and 1,1,1-TCA.

Biodegradation is already occurring as evidenced by the presence of the daughter products of TCE (*cis*-1,2-DCE) and 1,1,1-TCA (1,1-DCA). Furthermore, a dehaloccocoides ethogenes (DHE) Preliminary Chain Reaction (PCR) Assay test was conducted on groundwater samples. The test identifies the presence or absence of DHE microorganisms that are capable of complete dechlorination of TCE. The result of the test yielded a 3-plus which indicates that the necessary microbial suite is present for the reductive dechlorination of TCE, cis-1,2-DCE, and vinyl chloride.

1.4 Technology Description

In-Situ Reactive Zone (IRZ) has been selected to treat the impacts in the Building 1/36 Area. IRZ technology will be utilized to optimize and enhance biodegradation of chlorinated VOCs. The technology enhances biologically mediated reactions by supplying additional organic carbon to the groundwater. Microbes metabolize the supplemental organic carbon source and in the process drive the ORP to a lower, more strongly reduced state. Organic carbon is added by supplying the groundwater system with a carbohydrate source in the form of a mixture of carbohydrate and water.

Indigenous heterotrophic microorganisms present in the subsurface can readily degrade the carbohydrates. This metabolic degradation process utilizes available DO contained in groundwater, as well as other alternative electron acceptors, and as a result drives groundwater to a more anaerobic and reduced state. The bacterial community present in the aquifer prior to carbohydrate addition adapts to the changed biogeochemical aquifer conditions. In the enhanced subsurface environment the bacterial population

adjusts and facultative species begin to use alternative electron acceptors. In the absence of oxygen anaerobic populations grow. A bacterial community capable of fermenting carbohydrate sugars develops, producing volatile fatty acids, alcohols, and hydrogen. The volatile fatty acids and alcohols are further degraded to carbon dioxide and water and hydrogen is consumed as part of the reductive dechlorination process.

Hydrolysis and fermentation of carbohydrate ultimately result in the production of acetate and hydrogen, which serve as the most desirable sources of energy for bacteria using sulfate and carbon dioxide (CO_2) as electron acceptors. Methanogens use CO_2 as an electron acceptor and contribute to reductive dechlorination process. The reductive dechlorination breakdown pathways, intermediates for VOCs commonly found as environmental contaminants, and the cycling of organic carbon in an IRZ are presented in Figures 5 and 6.

Once organic carbon has been sufficiently delivered throughout the treatment area, subsequent additions of carbohydrate, if necessary, can be utilized to support the enhanced microbial population. This maintenance carbohydrate dosing occurs at intervals to maintain a target total organic compound (TOC) level sufficient to maintain the reduced environment that results from the activities of the enhanced microbial population. The reactive zone performance is measured by monitoring for the target contaminants and relative concentrations of degradation products and other indicator parameters in groundwater such as DO, ORP, pH, and specific conductivity.

The IRZ technology has been accepted by both federal and state regulatory agencies at more than 80 sites throughout the United States. More specifically, several sites in southern California are in progress. These sites are listed below:

- Electronics Manufacturer, City of Industry;
- Aerospace Company, Newbury Park;
- Automotive Manufacturer, Newport Beach;
- Electronics Manufacturer, Santa Ana;
- Dry Cleaner, Mission Viejo; and
- Aerospace Company, San Marcos.

1.5 Site Applicability

Anaerobic IRZ methods have successfully been applied to TCE, 1,1-DCE and the associated daughter products, in similar geologic settings to those encountered at the Site. The key to success will be engineering the process to deliver adequate organic carbon to ensure an environment in which reductive dechlorination can be maintained so that the process can proceed at an accelerated rate. Based on available Site data, daughter products have been detected in several wells on Site already. The presence of daughter products (notably *cis*-1,2-DCE) in the Building 1/36 area is also a site-specific piece of evidence that indicates that an appropriate microbial population is present at the Site.

In addition, biogeochemical water quality data also provides indications that the environment is anaerobic and reducing, and that microbial processes are contributing to creating this environment. Among this evidence is the following:

- DO measurements are less than 1.0 mg/L in groundwater collected from wells TMW-2 and WCC-03S. The low DO (<1 to 2 mg/L) indicates that groundwater is anaerobic.

- ORP is negative from groundwater samples collected from several wells (WCC-03S, WCC-06, and TMW-2). ORP ranged between –33 and –180 mV and indicates the groundwater is anaerobic and the environment is reducing.

- Moderate nitrate and sulfate depletion and trace methane provide additional evidence of microbial activity.

- Ferrous iron was detected in groundwater samples collected from several wells (WCC-03S, WCC-06, TMW-2, TMW-3, TMW-7, TMW-9, and TMW-12) at concentrations between 0.14 and 13.4 mg/L. The presence of ferrous iron in these wells above background indicates that groundwater is anaerobic and the environment is reducing.

- 3-plus DHE PCR analytical results from Building 1/36 provide additional evidence that enhanced biodegradation of chlorinated VOCs via reductive dechlorination can occur at this Site if an electron donor is present or provided.

The following sections discuss the objectives and specific tasks of the source-area groundwater IRZ pilot study program.

2. Source-Area Groundwater IRZ Pilot Study Objectives

The primary objectives of the proposed pilot study program in the Building 1/36 area are:

1. To reduce the mass of chlorinated VOCs in the VOC source-area in order to improve groundwater quality; and

2. To evaluate to what extent VOC concentrations can be reduced over time.

To meet these objectives food grade amendments will be added to create an IRZ to stimulate the natural VOC biodegradation processes. The following sections of this workplan detail the components of the proposed source-area pilot study program.

3. Source-Area Groundwater IRZ Pilot Study Program

This section describes the implementation of an IRZ pilot study in the Building 1/36 Area. The conceptual outline of the program is presented first, followed by a detailed description of the pilot program including hydraulic testing, well construction, amendment addition, monitoring, reporting, and closure activities.

3.1 Conceptual Program Outline

There are several discreet steps in the proposed IRZ pilot program that are necessary to implement the technology and to demonstrate its efficacy for achieving the stated objectives.

- The first phase of the IRZ pilot program will be basic hydraulic testing. The results of the hydraulic tests will serve as the basis to finalize the layout of the IRZ amendment points. The hydraulic testing will be used to confirm well spacing and construction, and to provide supplemental information related to amendment addition.

- The IRZ amendment points and monitoring well network will next be installed across the source-area plume. A total of approximately 170 IRZ amendment point locations (209 discrete points) and 7 new monitoring well locations (12 new discrete well points) will be installed in the targeted source-areas within the Upper B-Sand, the Lower B-Sand, and the C-Sand.

- Once the IRZ pilot system is constructed, process operation will begin with a baseline monitoring event using select wells. This data will be used to define the baseline biogeochemical and plume conditions within the target treatment zone.

- Amendment addition will begin immediately after the baseline samples are collected. A molasses and water solution will be used. Based on the response of the natural system to the molasses reagent, additional amendment events will be scheduled. In select areas of the IRZ, potassium bromide will be added to the molasses reagent solution. The bromide will serve as a tracer.

- Groundwater monitoring events targeting specific process analytes - redox, DO, electron acceptors and metabolic by-products, TOC, and VOCs and their daughter products - will be used to track the development and progress of the IRZ. A select set of amendment points and monitoring wells will be sampled based on a predetermined schedule. This schedule will be adjusted based on the results obtained in each sampling event. The ongoing site-wide monitoring program will be used to supplement the IRZ pilot study data collection program.

- Performance monitoring will be used to make decisions regarding the need, timing, and type of amendment additions, as well as, the success of the treatment process.

- Additional amendments may be applied based on the results of the process and performance monitoring. These amendments may include molasses, cheese whey and/or sodium bicarbonate.

- The pilot program will run for a period of approximately one year, over which active amendment additions will occur. The IRZ will then be monitored for approximately one additional year after which a summary report will be prepared and submitted to the Los Angeles Regional Water Quality Control Board (LARWQCB).

3.2 Detailed IRZ Pilot Study Plan

3.2.1 Hydraulic Tests

The geology in which the technology is being applied will exert considerable control over remediation efficiency. Mass transfer and distribution rates in porous media are the primary factors influencing the efficiency of the IRZ technology. The groundwater

seepage velocity, soil permeability, and the extent and depth of the TCE impacts have all been considered. These elements of the design have been factored into the preliminary proposed amendment point layout, the distance between the amendment points and the screened zone selected. Prior to installation of the amendment points, hydraulic tests will be conducted in each of the three zones (Upper B-Sand, Lower B-Sand, and C-Sand) to evaluate and refine the amendment point layout. The hydraulic test will be conducted within the treatment area (near proposed monitoring well MW-0006) prior to installing the IRZ amendment points. The purpose of the test is to confirm:

1. The hydraulic conductivity in each of the three zones (Upper B-Sand, Lower B-Sand, and C-Sand);

2. The radius of influence for the amendment points in each zone (determined by using potable water with a bromide tracer);

3. The effectiveness of using a ¾-inch diameter casing, installed using a cone penetrometer testing (CPT) rig. The effectiveness is defined as how easily the amendment point can be installed, how well the solution is distributed to the targeted zones, and the duration of delivery; and

4. Dilution effects of groundwater on the amendment solution.

The results of the test will be used to finalize the amendment point spacing, the number of amendment points, and the construction of the amendment points. The wells installed for the hydraulic test will be used in the final system as amendment points or monitoring points.

One hydraulic test point, two downgradient monitoring points, and one crossgradient monitoring point will be installed in each of the three zones (for a total of 12 points). The downgradient monitoring points will be located 5 and 15 feet downgradient of the hydraulic test point. The crossgradient monitoring point will be located 5 feet from the hydraulic test point. The hydraulic test points located in the Upper B-Sand and Lower B-Sand will be installed with ¾-inch diameter casings using a CPT rig. The point located in the C-Sand will be installed with 1.5-inch diameter casings using a hollow-stem auger (HSA) drill rig. The monitoring points will be installed as 3-well clusters using a HSA drill rig. Each well will consist of a 1.5-inch diameter casing, except for MW-0006 which will be constructed as described in section 3.2.2.

The hydraulic test will consist of four steps. The first step will be a slug test to evaluate the hydraulic conductivity of each zone. In the second step water will be delivered at varying pressures to determine the optimum delivery pressure. The pressure will be increased from approximately 10 to 40 pounds per square inch (psi) in approximate10 psi increments. The elapsed time to add 100 gallons will be recorded for each pressure. Pressure transducers will be installed in each monitoring well to evaluate changes in groundwater elevation during this step. This same procedure will be followed for each pressure step after groundwater levels have stabilized.

The third step will consist of adding approximately 400 gallons of water and bromide to each of the hydraulic test points; the pressure that will be used will be based on data from the second step described above. Potassium bromide (KBr) powder will be used as the source of bromide. (A Material Safety Data Sheet (MSDS) is included in Appendix A.) The tracer will be used to confirm groundwater flow rates and confirm estimated flow vectors and lateral spread of the IRZ. The concentration of the bromide solution in the amendment solution will be approximately 100 to 300 mg/L, in order to achieve a reasonable, measurable concentration in groundwater down gradient of the amendment point. Bromide has been accepted by state and federal agencies as a tracer for similar applications. A pressure transducer will be installed in each monitoring well to evaluate changes in groundwater elevation during this step. This same procedure will be followed for each zone.

The final step will consist of monitoring for bromide in the monitoring wells in each zone. Samples will be collected the same day as Step 3 and one week after Step 3. If the 400 gallons injected during the third step does not provide sufficient influence, then the amendment volume may be increased for the IRZ implementation.

Each step will be conducted in all three zones before moving to the next step. Potable water will be used throughout the hydraulic testing program.

3.2.2 Monitoring Well Locations/Installation

Seven new monitoring well locations (consisting of a total of 12 new well points) will be installed to monitor the progress of the pilot study program. These wells will consist of single wells and well clusters and are identified as MW-0001 through MW-0007 in Figure 7 and Table 1. Well cluster MW-0006 will be used during the hydraulic test discussed in Section 3.2.1. The locations and rationale for each of these well/well clusters are summarized below.

- MW-0001: The purpose of this well is to monitor groundwater in the Lower B-Sand. The well will be located between treatment lines, approximately 22.5 feet downgradient of an amendment point.

- MW-0002: The purpose of this well is to monitor groundwater in the C-Sand. The well will be located at the estimated edge of the zone of influence, approximately 15 downgradient of an amendment point.

- MW-0003: The purpose of this well cluster is to monitor groundwater in the Upper and Lower B-Sand. The well cluster will be located at the estimated edge of the zone of influence, approximately 15 downgradient of an amendment point.

- MW-0004: The purpose of this well is to monitor groundwater in the C-Sand and to assess if the reactive zone has traveled outside the treatment area. The well will be located approximately 90 feet downgradient from the last treatment row.

- MW-0005: The purpose of this well is to monitor groundwater in the Upper B-Sand and to assess if the reactive zone has trave led outside the treatment area. The well will be located approximately 90 feet downgradient from the furthest downgradient treatment row.

- MW-0006: The purpose of this well cluster is to monitor groundwater in the Upper and Lower B-Sand, and C-Sand. The well cluster will be located at the estimated edge of the zone of influence, approximately 30 feet downgradient of an amendment point.

- MW-0007: The purpose of this well cluster is to monitor groundwater from a background well (upgradient of the treatment area). The well will be a triple nested well to monitor the Upper and Lower B-Sand, and the C-Sand. The well cluster will be located approximately 30 feet upgradient of the first treatment row.

The monitoring wells will be installed using a hollow-stem auger drill rig. Well screens will be completed with 2-inch diameter 0.01-inch slotted PVC for all the new monitoring wells (MW-0001, MW-0002, MW-0004, and MW-00005). A minimum 4-foot bentonite seal will be used to isolate each zone of the dual- and triple-nested monitoring wells MW-0003, MW-0006, and MW-0007. A well construction permit will be obtained from the Los Angeles County Department of Health Services prior to installation. Typical monitoring well construction is presented in Figures 8A and 8B.

3.2.3 IRZ Amendment Point Locations

Temporary IRZ amendment points will be installed within the source-area zones to deliver carbohydrate solution. The source-area zone is defined as the area where concentrations of either TCE, 1,1-DCE, or 1,1,1-TCA have concentrations above 5,000 µg/L. Based on the groundwater data, the specific targeted aerial extent and depth intervals are summarized below.

- Upper B-Sand (approximately 65-85 ft bgs) – one area approximately 163,000 square feet (sf);
- Lower B-Sand (approximately 85-95 ft bgs) – three areas approximately 4,000 sf, 4,700 sf, and 12,600 sf; and
- C-Sand (approximately 95-115 ft bgs) – one area approximately 71,000 sf.

Preliminary design calculations using estimations of soil permeability (10^{-4} to 10^{-5} centimeter per second), groundwater flow velocity (average velocity of 15 feet per year), and anticipated amendment half-life resulted in a per point radius of influence (ROI) of 15 feet. Therefore, the amendment points will be spaced approximately 30 feet apart to establish a treatment line that is perpendicular to the direction of groundwater flow. In addition, the treatment lines will be spaced on 45-foot centers; this spacing is based on a minimum one-year travel time between lines. These distances may be adjusted based on the hydraulic testing (discussed in 3.2.1). Figure 7 illustrates the preliminary planned locations of the IRZ amendment points.

Due to the variability in site lithology, the IRZ amendment points will be installed to discretely target the three primary units (Upper B, Lower B and C-Sand units) in order to assure that the amendment solution reaches each of the targeted zones. IRZ amendment points in the Upper B-Sand will be screened to target the upper saturated sand zone located between approximately 65 and 85 feet bgs; the wells will be screened across the recent high water level. Amendment points targeting the Lower B-Sand will be screened between approximately 85 and 95 feet bgs. Amendment points targeting the C-Sand will be screened between approximately 95 and 115 feet bgs. IRZ amendment points will be constructed as pairs or triplets in areas where impacted zones overlap. For example, AW-0110 will be constructed to include two screened zones; one will be installed in the Upper B-Sand and one in the Lower B-Sand zone (AW-0110-A and AW-0110-B). Similarly, screens in AW-0034 will be completed in the

Upper B-Sand and the C-Sand (AW-0034-A and AW-0034-C).
Figure 9 illustrates a generalized cross section of the remediation area with amendment points.

3.2.4 IRZ Amendment Point Installation

Temporary IRZ amendment points will be installed throughout the area as shown on Figure 7. Assuming the 3/4-inch diameter schedule 40 polyvinyl chloride (PVC) amendment points are effective (per section 3.2.2), then a CPT rig will be used to install each amendment point in the Upper B-Sand zone (65-85 ft bgs). A CPT rig will also be used to install temporary amendment points in the Lower B-Sand (85-95 ft bgs); however, if refusal is encountered with this drilling method, then the points will be completed using a HSA drill rig.

Due to the depth of the C-Sand zone (95-115 ft bgs), a HSA drill rig will be used to install a 1.5-inch diameter PVC casing and screen. Where impacted zones overlap, in the case of the Upper B-Sand and C-Sand, and Upper B-Sand, Lower B-Sand, and C-Sand, then dual-nested and triple-nested temporary amendment points will be completed using HSA method. Each zone will be completed with a 1.5-inch diameter PVC casing at these dual- and triple-nested locations.

The temporary points to be installed using a CPT rig will be advanced with a 1.75-inch diameter hollow rod with a steel tip to the desired depth. The steel rod will be carefully removed leaving the PVC casing and screen in place. Slotted PVC (with 0.01-inch slots) will be used below the groundwater table (approximately 65 feet bgs) to the bottom of the borehole. The temporary points to be installed using HSA will be constructed inside an approximate 10-inch diameter borehole. Clean sand, bentonite seal, and cement slurry will be used to complete the construction of the amendment points. A construction permit will be obtained from the Los Angeles County Department of Health Services for the amendment points prior to installation. Typical amendment point construction details are presented in Figures 10A and 10B.

Twenty of the proposed IRZ amendment points will be constructed in pairs due to overlapping of the impacted Upper B-Sand and C-Sand plumes. These IRZ amendment points are AW-0026, AW-0027, AW-0028, AW-0029, AW-0032, AW-0033, AW-0034, AW-0035, AW-0036, AW-0042, AW-0043, AW-0044, AW-0045, AW-0053, AW-0054, AW-0064, AW-0065, AW-0075, AW-0086, and AW-0096.
Five of the proposed IRZ amendment points will be constructed in pairs due to overlapping of the impacted Upper B-Sand and Lower B-Sand plumes. These IRZ

amendment points are AW-0010, AW-0110, AW-0111, AW-0117 and AW-0118. Seven of the proposed IRZ amendment points will be constructed in triplets due to overlapping of the impacted Upper B-Sand, Lower B-Sand, and C-Sand plumes (these include IRZ amendment points AW-0011, AW-0012, AW-0013, AW-0019, AW-0020, AW-0021, and AW-0022). Table 1 summarizes the well construction details.

3.2.5 Carbohydrate Amendments

Carbohydrates are supplied using a number of different food-grade materials including molasses, cheese whey, corn syrup and others. For the Building 1/36 Area pilot study program molasses has been selected as the primary substrate and cheese whey as a potential secondary carbohydrate source. The balance of this discussion will focus on these carbohydrate sources.

Molasses provides a rapid establishment of the IRZ, while cheese whey provides a source of slow-release organic carbon and is sometimes used as a follow-up reagent to molasses - in case the molasses degradation is too rapid to provide cost efficient treatment. Both molasses and cheese whey are highly soluble and can move through both diffusive and advective processes into the finer-grained lithologies (for example, as observed at this Site in the Upper B-Sand, Lower B-Sand, and C-Sand) promoting reduction of adsorbed contaminant mass.

Both molasses and cheese whey are cost-effective and innocuous amendments that have been accepted by both state and federal regulatory agencies. Molasses and cheese whey are easily biodegradable carbon sources. In addition, both are edible materials and no undesirable effect is expected from their use. MSDS and product information for each is included in Appendix A.

3.2.6 Bromide Tracer

As described in section 3.2.1, bromide tracer will be used as part of the hydraulic test. In addition, a small amount of bromide tracer will be dissolved in the amendment solution that is used at AW-0062, and the dual-nested well AW-0110 (upgradient of MW-0002 and MW-0003, respectively) as part of the source-area IRZ pilot study program. These IRZ wells have been selected to assess performance of the IRZ in each groundwater zone (Upper B-Sand, Lower B-Sand, and C-Sand). The radius of influence, groundwater velocity, TOC movement, and the establishment and size of the IRZ can be evaluated using this data.

3.2.7 Sodium Bicarbonate Buffer

Sodium bicarbonate will be used as a buffering agent to maintain the pH of the groundwater above approximately 4.0 standard units (SU). The pH can decline in a mildly buffered groundwater as a result of the production of acidic biodegradation by-products. The need for the addition of a buffer will be determined based on the baseline, process and performance monitoring events. Between 5 to 20 pounds of sodium bicarbonate would be added to each amendment point, as necessary, during the carbohydrate solution amendment events.

Sodium bicarbonate is a food-grade reagent used to buffer the reactive zone local to an amendment well. It has been used at similar sites in California and other states. The MSDS for sodium bicarbonate is included in Appendix A.

3.2.8 Amendment Addition

Carbohydrate delivery will commence as soon as a Waste Discharge Requirement (WDR) permit - under the General WDR for remediation programs - can be granted by the LARWQCB.

The carbohydrate amendment (molasses or cheese whey) will be mixed with potable water at the Site to create an approximate 10 to 20 percent carbohydrate solution. The volume of carbohydrate solution added to each amendment point will be determined based on the hydraulic testing results. Typical IRZ programs use an amendment volume of less than 3 percent of the available pore volume within the estimated diameter of influence around each of the IRZ amendment points. The amendment will be utilized in the subsurface as a function of the volume added, the solution strength, the rate of groundwater flux, the age and stage of development of the microbial population and the presence and nature of available electron acceptors.

The amendment solution will be mixed above ground in a centrally located temporary mixing tank. One or more distribution systems will be used to deliver the solution. Each system will be connected to several IRZ amendment points for simultaneous solution addition. A quick connect/disconnect feeder manifold will be used to connect to the points. The feed line to each IRZ amendment point will include a flow rate and totalizer meter and ball valve. Water and molasses will be mixed at a planned ratio based on the site-specific hydraulic testing (Section 3.2.1). The carbohydrate solution volume, concentration, and frequencies may be adjusted based on the results of the field monitoring.

3.2.9 Source-Area Pilot Study Monitoring

In order to monitor and measure the performance of the process, three key elements will be monitored over the course of the source-area IRZ pilot study program.

1. **Delivery of adequate carbon substrate** to the subsurface will be measured by tracking TOC in the IRZ amendment points and monitoring wells. The target TOC concentration in the IRZ amendment points will be between 1,000 and 10,000 mg/L.

2. **Enhancement and maintenance of a reducing environment** capable of degrading the target VOCs. In order to assure that these conditions are created and maintained, DO, ferrous iron, sulfide and ORP will be measured in the field. These indicators will be supplemented with several laboratory parameters such as nitrate, nitrite, sulfate, methane, and dissolved manganese. The target environment will be marked by strongly reducing conditions (ORP < -50 mV and DO less than 1 mg/L), increased ferrous iron, and potentially methane and sulfide production, and reduced nitrate concentrations over background.

3. **Enhanced production of daughter products will be monitored** using VOC analysis (for *cis*-1,2-DCE, vinyl chloride, 1,1-DCA, and chloroethane), and light hydrocarbon analysis (for ethene and ethane). The ratio of source VOC concentrations to daughter products will be monitored over the course of the source-area IRZ pilot study program. A decline in the ratio is a positive indicator of success. In addition, an increase in the daughter product concentrations and the creation of ethene and ethane are also positive indicators of the technology's success.

Three types of monitoring events are planned: A baseline sampling event (prior to addition of carbohydrate solution); process monitoring events; and performance monitoring events. IRZ program monitoring will be conducted in accordance with Table 2. In general, process monitoring will be conducted approximately 2 weeks after the initiation of carbohydrate solution amendment addition and approximately every 4 to 6 weeks thereafter. This sampling event will include field monitoring for pH and laboratory TOC analysis. Performance monitoring will be conducted approximately 6 weeks after the initiation of carbohydrate solution amendment addition and approximately every 6 weeks thereafter. The performance monitoring events will consist of a more comprehensive suite of analytes. If additional carbohydrate delivery event(s) are needed, then the sequence and timing of the process and performance

monitoring event(s) may be modified to suit the modified amendment program. The projected schedule for the process and performance monitoring events are summarized in Table 2.

3.2.9.1 IRZ Monitoring Well Network

Monitoring will be conducted from one well upgradient of the treatment area (MW-0007), six wells located inside the treatment area (TMW-2 and TMW-7, and four proposed additional monitoring wells [MW-0001, MW-0002, MW-0003, and MW-0006]), and two wells downgradient of the treatment area (MW-0004 and MW-0005). The proposed monitoring well network for each zone is summarized below:

1. **Upper B-Sand (65-85 ft bgs)**: Monitoring wells MW-0003, MW-0005, TMW-2, and TMW-7 will be used to monitor changes in the Upper B-Sand. In addition, triple-nested wells (MW-0006 and MW-0007) will be used to monitor the Upper B-Sand.

2. **Lower B-Sand (85-95 ft bgs)**: Two wells will be installed in this zone, MW-0001 and MW-0003. In addition, triple-nested wells (MW-0006 and MW-0007) will be used to monitor the Lower B-Sand.

3. **C-Sand (95-115 ft bgs):** MW-0002 and MW-0004 will be installed to monitor the C-Sand. In addition, triple-nested wells (MW-0006 and MW-0007) will be used to monitor the C-Sand.

Five of the IRZ amendment points (AW-0030, AW-0062, AW-0074, AW-0111, and AW-0166) will also be used to collect supplemental data specific to the amendment addition (specifically, TOC and pH). Figure 7 illustrates the locations of the monitoring wells.

3.2.9.2 Baseline Monitoring

Significant groundwater monitoring data exists for the Site, including the former Building 1/36 source-area. To augment this database, an additional baseline groundwater monitoring event will be conducted from the two existing wells (TMW-2 and TMW-7), seven IRZ monitoring wells (MW-0001 through MW-0007), and five IRZ amendment points (AW-0030, AW-0062, AW-0074, AW-0111, and AW-0166) located within the source-area to evaluate and document groundwater conditions prior to carbohydrate addition. These data will be added to the Site groundwater database

and will provide a firm basis of conditions against which IRZ performance can be compared. Samples will be collected from these points and analyzed for the suite of analytes as summarized in Table 2.

During the baseline sampling event, groundwater samples will be collected and analyzed for organic and inorganic parameters to evaluate the geochemical environment in the area of concern. These analyses will include general groundwater quality parameters, electron acceptors, and biodegradation byproducts. The parameters are summarized below.

General Groundwater Quality Parameters - These parameters are measured in groundwater at the wellhead for the wells associated with the source-area IRZ pilot study program, and include indicator parameters that can be used to measure the development of the reactive zone in groundwater. The parameters include ORP, pH, temperature, specific conductance, VOCs, and TOC. The relative presence of these analytes can also be used as an indication of the presence of biodegradation of the VOCs, and provide a basis for carbohydrate addition frequency, strength, and volume.

Electron Acceptors - Analysis for electron acceptors indicate the relative levels of compounds present in the groundwater, which serve as alternate electron acceptors once oxygen is depleted from the aquifer, and are a key indicator of anticipated success of the remedy. These compounds include DO, nitrate, iron, manganese, sulfate, and CO_2.

Biodegradation By-products - Analysis for the biodegradation byproducts indicate the relative levels of compounds formed by biodegradation and are therefore also a good indicator of reductive dechlorination. These byproduct compounds include dissolved iron and manganese, nitrite, CO_2, nitrogen, sulfide, methane, VOC daughter products, chloride, ethene, and ethane.

Sampling will be conducted in accordance with Section 4 and Table 2 of the workplan.

3.2.9.3 Process Monitoring

Process monitoring will be conducted in weeks 2, 6, 12, 18, 24, 36 and 52. The purpose of these monitoring events is to measure the effect of the carbohydrate solution on the groundwater conditions at, and near, the IRZ amendment points. This information will be used to evaluate the need for adjustments to the amendment addition program. Groundwater samples will be collected and samples will be analyzed in accordance

with Table 2. In general, samples will be analyzed for pH using a field test protocol. Samples will also be sent to the laboratory for TOC analysis. Samples will be collected from AW-0030, AW-0062, AW-0074, AW-0111, and AW-0166.

In addition, during the latter four sampling events the performance monitoring data collected from the monitoring wells will be used to supplement the process monitoring data collected from the five IRZ amendment points. The carbohydrate solution may be adjusted and/or additional carbohydrate delivery event(s) may be conducted based on the data collected during these events.

The frequency, wells and points sampled, and the list of analytes may be changed based on the data collected during each sampling event. This flexibility is necessary to assure that adequate, relevant water quality data is collected as the IRZ program progresses. Any changes, and the rationale for such changes, will be presented as part of the remediation program reporting.

3.2.9.4 Performance Monitoring

Performance monitoring will be conducted at 6, 12, 18, 24, 36, and 52 weeks after the initial carbohydrate delivery event. This monitoring will be more comprehensive than the process monitoring. Samples will be collected from some or all of the new monitoring wells in accordance with Table 2. Field parameters will be identical to the baseline event and groundwater samples will be collected from each monitoring well using low-flow purge techniques and will be analyzed for the parameters listed in Table 2. Groundwater sampling is discussed in Section 4.0.

These data will be used along with the process monitoring data to evaluate the progress of the reactive zone development and to make adjustments to the amendment addition program.

Following the week 52 performance monitoring event, performance monitoring will be performed as part of the site-wide monitoring program from select IRZ monitoring wells for a period of one year. Subsequent sampling will be based on the data collected in predecessor events.

3.2.9.5 Site Wide Monitoring

It should be noted that a Site-wide groundwater monitoring program approved by the LARWQCB is currently in place and being used to monitor Site-wide groundwater quality (Haley & Aldrich, 2001). This groundwater monitoring program will be continued during the source-area IRZ pilot study program and will be amended as necessary to provide remediation performance monitoring data for LARWQCB reporting.

3.2.10 Data Evaluation and Amendment Adjustments

The process data collected in the monitoring program will be used to assess the establishment/strength of the IRZ and to determine if subsequent amendment addition(s) are needed. The data will also be used to determine whether to modify or to maintain the planned monitoring program. ORP, pH, TOC, VOC ratio, other biogeochemical indicator parameters (i.e. nitrate, sulfate, sulfide, ferrous iron, etc.), and the bromide tracer will be evaluated in the monitoring wells to define the rate of TOC use and the natural groundwater velocity. The data will also define how well buffered the system is – pH –electron acceptor use, and how well the target VOCs are being degraded and to what extent.

Groundwater monitoring data will be reviewed and used to determine the need to adjust the strength, frequency, volume, and makeup of the amendment additions. Adjustments could include more frequent amendment additions, an increase or decrease in solution strength, an increase or decrease in solution volume, the use of cheese whey instead of molasses, and/or the addition of sodium bicarbonate to control pH.

3.2.11 Termination of Pilot Study Amendments and System Decommissioning

The IRZ pilot study amendment additions will be terminated after one year of operation. One year of post-amendment monitoring will be conducted as part of the site-wide monitoring program. At the conclusion of the post-amendment monitoring the IRZ system may be removed. Decommissioning of the system will include abandonment of all the temporary IRZ amendment points and select IRZ monitoring wells. Wells and amendment points will be abandoned in accordance with State of California Department of Water Resources water well standards (Bulletins 74-81 and 74-90).

4. Sampling and Analysis Plan/QA

Monitoring wells will be gauged prior to collecting groundwater samples to determine static water levels and total well depth. Low-flow purging (less then 250 milliliters per minute will be used for sampling events to collect groundwater samples to minimize disturbance to the groundwater in the well. The groundwater sample analytical program is provided in Table 2.

Samples collected from each well will be tested for biogeochemical parameters using a YSI unit, field test kits, and fixed-base laboratory analyses. The YSI unit, with flow-through cell, will be used to measure pH, DO, ORP, specific conductance, and temperature. Hach, Inc. colorimetric field test kits will be used to measure ferrous iron, and hydrogen sulfide. Following field test kit analyses, groundwater samples will be collected for groundwater quality parameters, terminal electron acceptors, and degradation products. Samples to be analyzed for dissolved metals will be filtered in the field immediately following sample collection at each of the sampling locations.

Samples collected for laboratory analyses will be properly labeled and packaged in cooled ice chests at a temperature of approximately 4 degrees Centigrade (°C) and delivered via commercial carrier to a state-certified laboratory (Severn-Trent Laboratories). Samples will also be sent to VaporTech Services, Inc. located in Valencia, Pennsylvania for dissolved gas analysis. Samples will be delivered using standard chain-of-custody protocol. Field and laboratory data will be collected and reported in accordance with the BRC Data Management Plan (Boeing 2001). To verify laboratory results, 10% of the laboratory VOC data will be subjected to third-party data validation.

5. Permits

Several permits will be required before implementation of the pilot study program. The permits that will be needed include (1) a WDR permit from the LARWQCB, (2) well construction permits from the Los Angeles County Department of Health Services, and (3) water hydrant permit from the Los Angeles Department of Water and Power.

6. Reporting

Semi-annual data reports will be prepared and submitted to the LARWQCB to document field activities, summarize analytical data, and present the ongoing remedial performance and progress per the WDR permit.

A summary report will be prepared at the conclusion of the program. The report will document source-area IRZ pilot study activities, monitoring and sampling activities, analytical results, IRZ results, and any recommended future actions.

A reporting schedule will be prepared upon approval of this workplan and receipt of a WDR permit.

7. Schedule

The estimated duration of this pilot test program is two and one-half years. The Phase I hydraulic testing will be initiated as soon as this workplan is approved and a WDR permit is granted by the LARWQCB. Installation of the IRZ amendment points and monitoring wells will follow the hydraulic testing. Baseline monitoring and the carbohydrate delivery events will begin three to six months after the WDR permit approval. Amendment events will be conducted for the next 12 months of the pilot program based on the monitoring data collected. Monitoring events will be conducted as provided in Table 2.

Post-amendment monitoring will be conducted for twelve months following the amendment program. A final report with a summary of the pilot test results, conclusions and recommendations based on the pilot data will be completed and issued to the LARWQCB within three months following the post-amendment monitoring period.

8. Health and Safety

Work will be completed by 40-hour Occupational Safety and Health Administration (OSHA) trained personnel using Level D protection. Work will be conducted in accordance with the existing health and safety plan (Haley & Aldrich, June 8, 2001) as amended for the scope of work discussed in this workplan.

9. Residuals Management

Residuals generated during the implementation of the source-area IRZ pilot study program will include soil cuttings and groundwater monitoring well development and purge water. Soil cuttings generated during the drilling of the monitoring wells will be placed in a roll-off bin or in a stockpile on plastic sheeting covered with plastic sheeting. Upon completion of drilling activities, the soil will be sampled and characterized for disposition in accordance with Site soil disposition protocols.

Groundwater monitoring well development and purge water will be contained in tanks or 55-gallon drums and labeled. The water will be stored in a common area of the Site designated by BRC. Upon completion of field activities, the water will be characterized for proper off-Site disposition by BRC.

10. References

Boeing, 2001, Data Management Plan, Revision 3, February 2, 2001.

England-Geosystem/Haley & Aldrich, Inc., 2001. Standard Operating Procedures for Measuring Natural Attenuation Parameters at Boeing Realty Corporation Former C-6 Facility-Revision 1.0, January 9, 2001.

Haley & Aldrich, Inc., Site-Specific Health & Safety Plan, June 8, 2001.

Haley & Aldrich, Inc., 2001, Groundwater Monitoring Workplan 2002, Boeing Realty Corporation, Former C-6 Facility, Los Angeles, California, December 20, 2001.

Tables

[redacted]

Table 1
Proposed Monitoring and Amendment Well Information
Former Boeing C-6 Facility (Building 1/36 Area), Los Angeles, California

Well ID		Zone	Well Diameter (in.)	Approximate Total Depth (ft)	Approximate Screened Interval (ft)
Well No.	Suffix				
Monitoring Wells					
MW0001	B	Lower B-Sand	2.0	95	85-95
MW0002	C	C-Sand	2.0	115	95-115
MW0003	A	Upper B-Sand	2.0	85	65-85
MW0003	B	Lower B-Sand	2.0	95	85-95
MW0004	C	C-Sand	2.0	115	95-115
MW0005	A	Upper B-Sand	2.0	85	65-85
MW0006	A	Upper B-Sand	2.0	85	65-85
MW0006	B	Lower B-Sand	2.0	95	85-95
MW0006	C	C-Sand	2.0	115	95-115
MW0007	A	Upper B-Sand	2.0	85	65-85
MW0007	B	Lower B-Sand	2.0	95	85-95
MW0007	C	C-Sand	2.0	115	95-115
Amendment Wells					
AW0001	A	Upper B-Sand	3/4	85	65-85
AW0002	A	Upper B-Sand	3/4	85	65-85
AW0003	A	Upper B-Sand	3/4	85	65-85
AW0004	A	Upper B-Sand	3/4	85	65-85
AW0005	A	Upper B-Sand	3/4	85	65-85
AW0006	A	Upper B-Sand	3/4	85	65-85
AW0007	A	Upper B-Sand	3/4	85	65-85
AW0008	A	Upper B-Sand	3/4	85	65-85
AW0009	A	Upper B-Sand	3/4	85	65-85
AW0010	A	Upper B-Sand	3/4	85	65-85
AW0010	B	Lower B-Sand	3/4	95	85-95
AW0011	A	Upper B-Sand	3/4	85	65-85
AW0011	B	Lower B-Sand	1.5	95	85-95
AW0011	C	C-Sand	1.5	115	95-115
AW0012	A	Upper B-Sand	1.5	85	65-85
AW0012	B	Lower B-Sand	1.5	95	85-95
AW0012	C	C-Sand	1.5	115	95-115
AW0013	A	Upper B-Sand	1.5	85	65-85
AW0013	B	Lower B-Sand	1.5	95	85-95
AW0013	C	C-Sand	1.5	115	95-115
AW0014	A	Upper B-Sand	3/4	85	65-85
AW0015	A	Upper B-Sand	3/4	85	65-85
AW0016	A	Upper B-Sand	3/4	85	65-85
AW0017	A	Upper B-Sand	3/4	85	65-85
AW0018	A	Upper B-Sand	3/4	85	65-85
AW0019	A	Upper B-Sand	1.5	85	65-85
AW0019	B	Lower B-Sand	1.5	95	85-95
AW0019	C	C-Sand	1.5	115	95-115
AW0020	A	Upper B-Sand	1.5	85	65-85
AW0020	B	Lower B-Sand	1.5	95	85-95
AW0020	C	C-Sand	1.5	115	95-115
AW0021	A	Upper B-Sand	1.5	85	65-85
AW0021	B	Lower B-Sand	1.5	95	85-95
AW0021	C	C-Sand	1.5	115	95-115

Table 1
Proposed Monitoring and Amendment Well Information
Former Boeing C-6 Facility (Building 1/36 Area), Los Angeles, California

Well ID		Zone	Well Diameter (in.)	Approximate Total Depth (ft)	Approximate Screened Interval (ft)
Well No.	Suffix				
AW0022	A	Upper B-Sand	1.5	85	65-85
AW0022	B	Lower B-Sand	1.5	95	85-95
AW0022	C	C-Sand	1.5	115	95-115
AW0023	A	Upper B-Sand	3/4	85	65-85
AW0024	A	Upper B-Sand	3/4	85	65-85
AW0025	A	Upper B-Sand	3/4	85	65-85
AW0026	A	Upper B-Sand	1.5	85	65-85
AW0026	C	C-Sand	1.5	115	95-115
AW0027	A	Upper B-Sand	1.5	85	65-85
AW0027	C	C-Sand	1.5	115	95-115
AW0028	A	Upper B-Sand	1.5	85	65-85
AW0028	C	C-Sand	1.5	115	95-115
AW0029	A	Upper B-Sand	1.5	85	65-85
AW0029	C	C-Sand	1.5	115	95-115
AW0030	A	Upper B-Sand	3/4	85	65-85
AW0031	A	Upper B-Sand	3/4	85	65-85
AW0032	A	Upper B-Sand	1.5	85	65-85
AW0032	C	C-Sand	1.5	115	95-115
AW0033	A	Upper B-Sand	1.5	85	65-85
AW0033	C	C-Sand	1.5	115	95-115
AW0034	A	Upper B-Sand	1.5	85	65-85
AW0034	C	C-Sand	1.5	115	95-115
AW0035	A	Upper B-Sand	1.5	85	65-85
AW0035	C	C-Sand	1.5	115	95-115
AW0036	A	Upper B-Sand	1.5	85	65-85
AW0036	C	C-Sand	1.5	115	95-115
AW0037	A	Upper B-Sand	3/4	85	65-85
AW0038	A	Upper B-Sand	3/4	85	65-85
AW0039	A	Upper B-Sand	3/4	85	65-85
AW0040	C	C-Sand	1.5	115	95-115
AW0041	C	C-Sand	1.5	115	95-115
AW0042	A	Upper B-Sand	1.5	85	65-85
AW0042	C	C-Sand	1.5	115	95-115
AW0043	A	Upper B-Sand	1.5	85	65-85
AW0043	C	C-Sand	1.5	115	95-115
AW0044	A	Upper B-Sand	1.5	85	65-85
AW0044	C	C-Sand	1.5	115	95-115
AW0045	A	Upper B-Sand	1.5	85	65-85
AW0045	C	C-Sand	1.5	115	95-115
AW0046	A	Upper B-Sand	3/4	85	65-85
AW0047	A	Upper B-Sand	3/4	85	65-85
AW0048	A	Upper B-Sand	3/4	85	65-85
AW0049	C	C-Sand	1.5	115	95-115
AW0050	C	C-Sand	1.5	115	95-115
AW0051	C	C-Sand	1.5	115	95-115
AW0052	C	C-Sand	1.5	115	95-115
AW0053	A	Upper B-Sand	1.5	85	65-85
AW0053	C	C-Sand	1.5	115	95-115

Table 1
Proposed Monitoring and Amendment Well Information
Former Boeing C-6 Facility (Building 1/36 Area), Los Angeles, California

Well ID		Zone	Well Diameter (in.)	Approximate Total Depth (ft)	Approximate Screened Interval (ft)
Well No.	Suffix				
AW0054	A	Upper B-Sand	1.5	85	65-85
AW0054	C	C-Sand	1.5	115	95-115
AW0055	A	Upper B-Sand	3/4	85	65-85
AW0056	A	Upper B-Sand	3/4	85	65-85
AW0057	A	Upper B-Sand	3/4	85	65-85
AW0058	A	Upper B-Sand	3/4	85	65-85
AW0059	C	C-Sand	1.5	115	95-115
AW0060	C	C-Sand	1.5	115	95-115
AW0061	C	C-Sand	1.5	115	95-115
AW0062	C	C-Sand	1.5	115	95-115
AW0063	C	C-Sand	1.5	115	95-115
AW0064	A	Upper B-Sand	1.5	85	65-85
AW0064	C	C-Sand	1.5	115	95-115
AW0065	A	Upper B-Sand	1.5	85	65-85
AW0065	C	C-Sand	1.5	115	95-115
AW0066	A	Upper B-Sand	3/4	85	65-85
AW0067	A	Upper B-Sand	3/4	85	65-85
AW0068	A	Upper B-Sand	3/4	85	65-85
AW0069	A	Upper B-Sand	3/4	85	65-85
AW0070	C	C-Sand	1.5	115	95-115
AW0071	C	C-Sand	1.5	115	95-115
AW0072	C	C-Sand	1.5	115	95-115
AW0073	C	C-Sand	1.5	115	95-115
AW0074	C	C-Sand	1.5	115	95-115
AW0075	A	Upper B-Sand	1.5	85	65-85
AW0075	C	C-Sand	1.5	115	95-115
AW0076	A	Upper B-Sand	3/4	85	65-85
AW0077	A	Upper B-Sand	3/4	85	65-85
AW0078	A	Upper B-Sand	3/4	85	65-85
AW0079	A	Upper B-Sand	3/4	85	65-85
AW0080	A	Upper B-Sand	3/4	85	65-85
AW0081	C	C-Sand	1.5	115	95-115
AW0082	C	C-Sand	1.5	115	95-115
AW0083	C	C-Sand	1.5	115	95-115
AW0084	C	C-Sand	1.5	115	95-115
AW0085	C	C-Sand	1.5	115	95-115
AW0086	A	Upper B-Sand	1.5	85	65-85
AW0086	C	C-Sand	1.5	115	95-115
AW0087	A	Upper B-Sand	3/4	85	65-85
AW0088	A	Upper B-Sand	3/4	85	65-85
AW0089	A	Upper B-Sand	3/4	85	65-85
AW0090	A	Upper B-Sand	3/4	85	65-85
AW0091	A	Upper B-Sand	3/4	85	65-85
AW0092	C	C-Sand	1.5	115	95-115
AW0093	C	C-Sand	1.5	115	95-115
AW0094	C	C-Sand	1.5	115	95-115
AW0095	C	C-Sand	1.5	115	95-115
AW0096	A	Upper B-Sand	1.5	85	65-85

Table 1
Proposed Monitoring and Amendment Well Information
Former Boeing C-6 Facility (Building 1/36 Area), Los Angeles, California

Well ID		Zone	Well Diameter (in.)	Approximate Total Depth (ft)	Approximate Screened Interval (ft)
Well No.	Suffix				
AW0096	C	C-Sand	1.5	115	95-115
AW0097	A	Upper B-Sand	3/4	85	65-85
AW0098	A	Upper B-Sand	3/4	85	65-85
AW0099	A	Upper B-Sand	3/4	85	65-85
AW0100	A	Upper B-Sand	3/4	85	65-85
AW0101	A	Upper B-Sand	3/4	85	65-85
AW0102	A	Upper B-Sand	3/4	85	65-85
AW0103	C	C-Sand	1.5	115	95-115
AW0104	C	C-Sand	1.5	115	95-115
AW0105	C	C-Sand	1.5	115	95-115
AW0106	C	C-Sand	1.5	115	95-115
AW0107	A	Upper B-Sand	3/4	85	65-85
AW0108	A	Upper B-Sand	3/4	85	65-85
AW0109	A	Upper B-Sand	3/4	85	65-85
AW0110	A	Upper B-Sand	3/4	85	65-85
AW0110	B	Lower B-Sand	3/4	95	85-95
AW0111	A	Upper B-Sand	3/4	85	65-85
AW0111	B	Lower B-Sand	3/4	95	85-95
AW0112	A	Upper B-Sand	3/4	85	65-85
AW0113	A	Upper B-Sand	3/4	85	65-85
AW0114	A	Upper B-Sand	3/4	85	65-85
AW0115	A	Upper B-Sand	3/4	85	65-85
AW0116	A	Upper B-Sand	3/4	85	65-85
AW0117	A	Upper B-Sand	3/4	85	65-85
AW0117	B	Lower B-Sand	3/4	95	85-95
AW0118	A	Upper B-Sand	3/4	85	65-85
AW0118	B	Lower B-Sand	3/4	95	85-95
AW0119	A	Upper B-Sand	3/4	85	65-85
AW0120	A	Upper B-Sand	3/4	85	65-85
AW0121	A	Upper B-Sand	3/4	85	65-85
AW0122	A	Upper B-Sand	3/4	85	65-85
AW0123	A	Upper B-Sand	3/4	85	65-85
AW0124	A	Upper B-Sand	3/4	85	65-85
AW0125	A	Upper B-Sand	3/4	85	65-85
AW0126	A	Upper B-Sand	3/4	85	65-85
AW0127	A	Upper B-Sand	3/4	85	65-85
AW0128	A	Upper B-Sand	3/4	85	65-85
AW0129	A	Upper B-Sand	3/4	85	65-85
AW0130	A	Upper B-Sand	3/4	85	65-85
AW0131	A	Upper B-Sand	3/4	85	65-85
AW0132	A	Upper B-Sand	3/4	85	65-85
AW0133	A	Upper B-Sand	3/4	85	65-85
AW0134	A	Upper B-Sand	3/4	85	65-85
AW0135	A	Upper B-Sand	3/4	85	65-85
AW0136	A	Upper B-Sand	3/4	85	65-85
AW0137	A	Upper B-Sand	3/4	85	65-85
AW0138	A	Upper B-Sand	3/4	85	65-85
AW0139	A	Upper B-Sand	3/4	85	65-85

Table 1
Proposed Monitoring and Amendment Well Information
Former Boeing C-6 Facility (Building 1/36 Area), Los Angeles, California

Well ID		Zone	Well Diameter (in.)	Approximate Total Depth (ft)	Approximate Screened Interval (ft)
Well No.	Suffix				
AW0140	A	Upper B-Sand	3/4	85	65-85
AW0141	A	Upper B-Sand	3/4	85	65-85
AW0142	A	Upper B-Sand	3/4	85	65-85
AW0143	A	Upper B-Sand	3/4	85	65-85
AW0144	A	Upper B-Sand	3/4	85	65-85
AW0145	A	Upper B-Sand	3/4	85	65-85
AW0146	A	Upper B-Sand	3/4	85	65-85
AW0147	A	Upper B-Sand	3/4	85	65-85
AW0148	A	Upper B-Sand	3/4	85	65-85
AW0149	A	Upper B-Sand	3/4	85	65-85
AW0150	A	Upper B-Sand	3/4	85	65-85
AW0151	A	Upper B-Sand	3/4	85	65-85
AW0152	A	Upper B-Sand	3/4	85	65-85
AW0153	A	Upper B-Sand	3/4	85	65-85
AW0154	A	Upper B-Sand	3/4	85	65-85
AW0155	A	Upper B-Sand	3/4	85	65-85
AW0156	A	Upper B-Sand	3/4	85	65-85
AW0157	A	Upper B-Sand	3/4	85	65-85
AW0158	A	Upper B-Sand	3/4	85	65-85
AW0159	A	Upper B-Sand	3/4	85	65-85
AW0160	A	Upper B-Sand	3/4	85	65-85
AW0161	A	Upper B-Sand	3/4	85	65-85
AW0162	A	Upper B-Sand	3/4	85	65-85
AW0163	A	Upper B-Sand	3/4	85	65-85
AW0164	A	Upper B-Sand	3/4	85	65-85
AW0165	A	Upper B-Sand	3/4	85	65-85
AW0166	B	Lower B-Sand	3/4	95	85-95
AW0167	B	Lower B-Sand	3/4	95	85-95
AW0168	B	Lower B-Sand	3/4	95	85-95
AW0169	B	Lower B-Sand	3/4	95	85-95
AW0170	B	Lower B-Sand	3/4	95	85-95

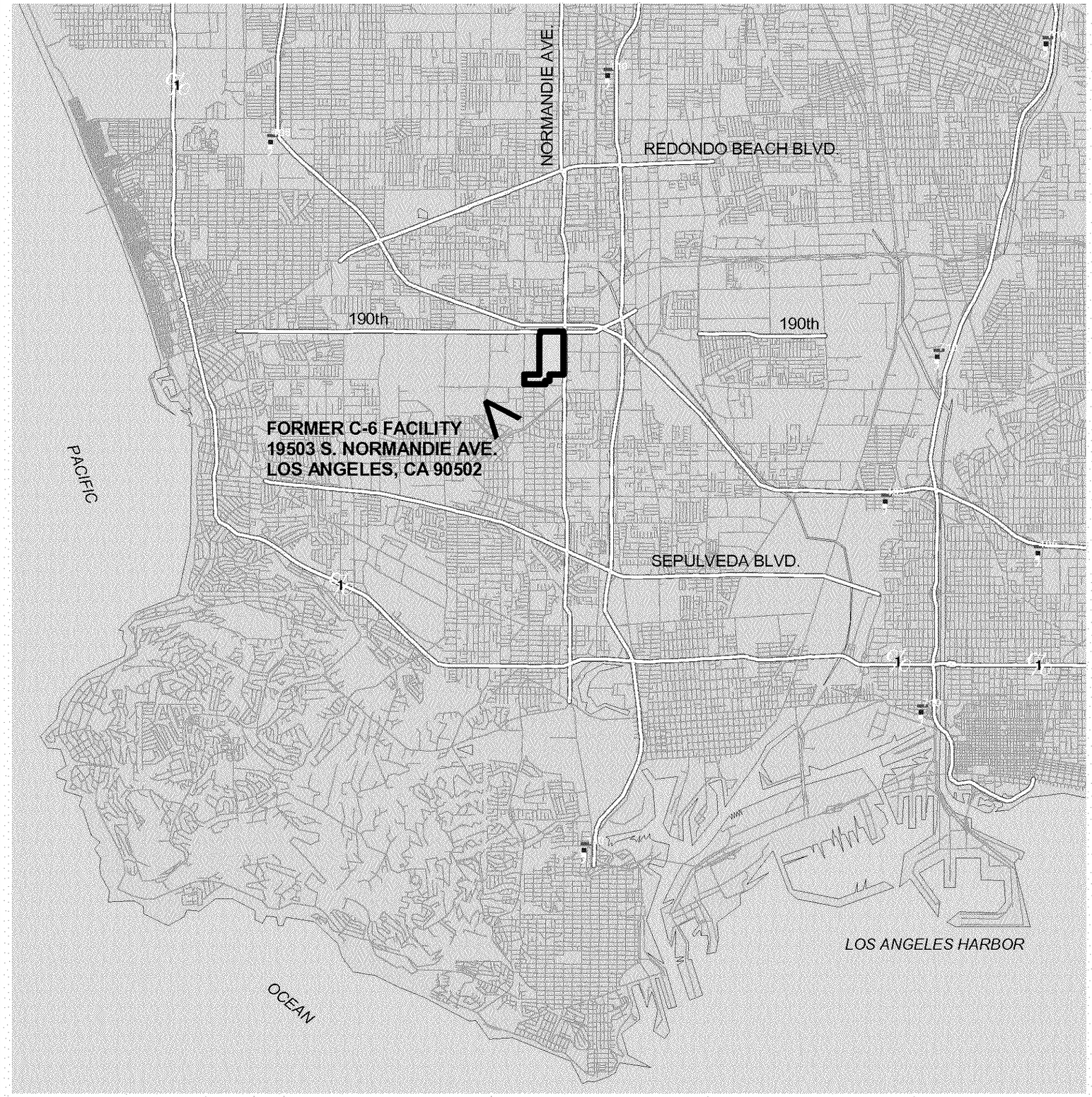
Note:
(1) Wells TMW-2 and TMW-7 will also be included in the monitoring program. These wells are screened in the B-Sand.

Table 2
Carbohydrate Addition and Groundwater Monitoring Schedule
Former Boeing C-6 Facility (Building 1/36 Area), Los Angeles, California

			Week									
			-2	0	0	2	6	12	18	24	36	52
		Workplan Approved	IRZ Amendment Point and Monitoring Well Installation	Baseline Monitoring	Carbohydrate Addition	Process Monitoring (5)	Performance Monitoring	Performance Monitoring	Performance Monitoring (6)	Performance Monitoring (6)	Performance Monitoring (6)	Performance Monitoring (6,7)
Amendment addition					X							
Field Parameters	**EPA Analytical Method**											
Dissolved oxygen	NA[1][2]			x			x	x	x	x	x	x
Oxidation reduction potential (ORP)	NA[1]			x			x	x	x	x	x	x
pH	NA[1]			x		x (2)	x	x	x	x	x	x
Temperature	NA[1]			x			x	x	x	x	x	x
Specific conductance	NA[1]			x			x	x	x	x	x	x
Iron, ferrous	NA[2]			x			x	x	x	x	x	x
Hydrogen sulfide	NA[2]			x			x	x	x	x	x	x
Sulfides	NA[2]			x			x	x	x	x	x	x
Laboratory Analysis												
Volatile Organic Compounds	8260			x			x	x	x	x	x	x
Total organic carbon (TOC)	415.1			x		x	x	x	x	x	x	x
Manganese, total	6010A			x						x	x	x
Manganese, dissolved	6010A			x			x	x	x	x	x	x
Iron, total	6010A			x						x	x	x
Sulfate	375.4			x			x	x	x	x	x	x
Nitrate	353.2			x			x	x	x	x	x	x
Nitrite	353.2			x						x	x	x
Chloride	325.2			x						x	x	x
Permanent Gases												
Dissolved Oxygen	VaporTech[3]			x			x	x	x	x	x	x
Carbon dioxide	VaporTech[3]			x			x	x	x	x	x	x
Nitrogen	VaporTech[3]			x			x	x	x	x	x	x
Methane	VaporTech[3]			x			x	x	x	x	x	x
Ethane	VaporTech[3]			x			x	x	x	x	x	x
Ethene	VaporTech[3]			x			x	x	x	x	x	x
Tracer												
Bromide	320.1			x			x	x	x	x	x	x
Wells to be Sampled (4,5)				1,2,3,4,5,6,7,8,9		(5)	1,2,3,6	1,2,3,6,8,9	1,2,3,6	1,2,3,6,8,9	1,2,3,6,8,9	1,2,3,4,5,6,7,8,9

Notes:
(1) NA - not applicable. Parameters will be measured in the field using a YSI 6000 Water Quality Transmitter unit.
(2) NA - not applicable. Parameters will be measured in the field using a Hach test kit.
(3) Method developed by VaporTech, Inc.
(4) 1: MW-0001; 2:MW-0002; 3:MW-0003; 4:MW-0004, 5:MW-0005, 6:MW-0006, 7:MW-0007, 8:TMW-2; 9:TMW-7.
(5) The process monitoring events will be conducted in weeks 2, 6, 12, 18, 24, 36, and 52 for TOC and pH. AW-0030, AW-0062, AW-0074, AW-0111, and AW-0166 will be sampled as part of these events. During the baseline event, AW-0030, AW-0062, AW-0074, AW-0111, and AW-0166 will be sampled for TOC, pH and VOCs.
(6) The timing and analysis conducted during these events may be adjusted to accommodate data collected in previous events.

Figures



N

EXPLANATION

BOEING REALTY CORPORATION:
FORMER C-6 FACILITY

REFERENCE:
Base map downloaded from 'Tiger File' data website hosted by ESRI.

0 1 2 Miles

APPROXIMATE HORIZONTAL SCALE

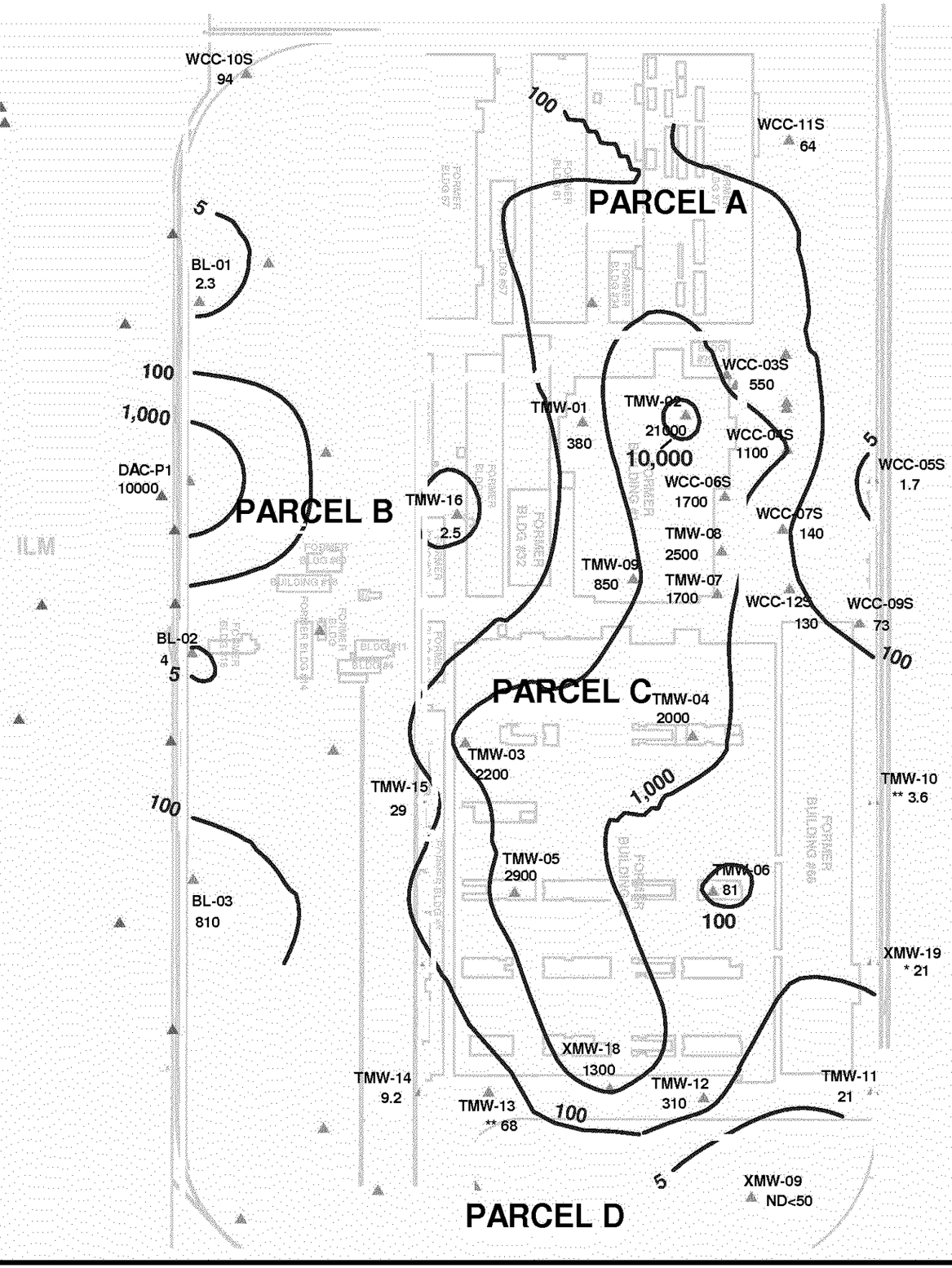
FIGURE 1

SITE LOCATION MAP

FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

PREPARED FOR
BOEING REALTY CORPORATION
LONG BEACH, CALIFORNIA

HALEY & ALDRICH
ENGLAND GEOSYSTEM
ENVIRONMENTAL ENGINEERING



EXPLANATION

WCC-11S ▲ 64	BOEING GROUNDWATER MONITORING WELL SHOWING TCE CONCENTRATION IN ug/l
▲	ILM GROUNDWATER MONITORING WELL
100	LINE OF EQUAL TCE CONCENTRATION IN µg/l

NOTES:
1. ISOCONCENTRATION CONTOUR INTERVAL = VARIABLE

REFERENCE:
AERIAL PHOTO PROVIDED BY GLOBE EXPLORER AND ORTHORECTIFIED TO NAD 83 CALIFORNIA STATE PLANE ZONE 5 IN FEET.

0 200 400 Feet

APPROXIMATE HORIZONTAL SCALE

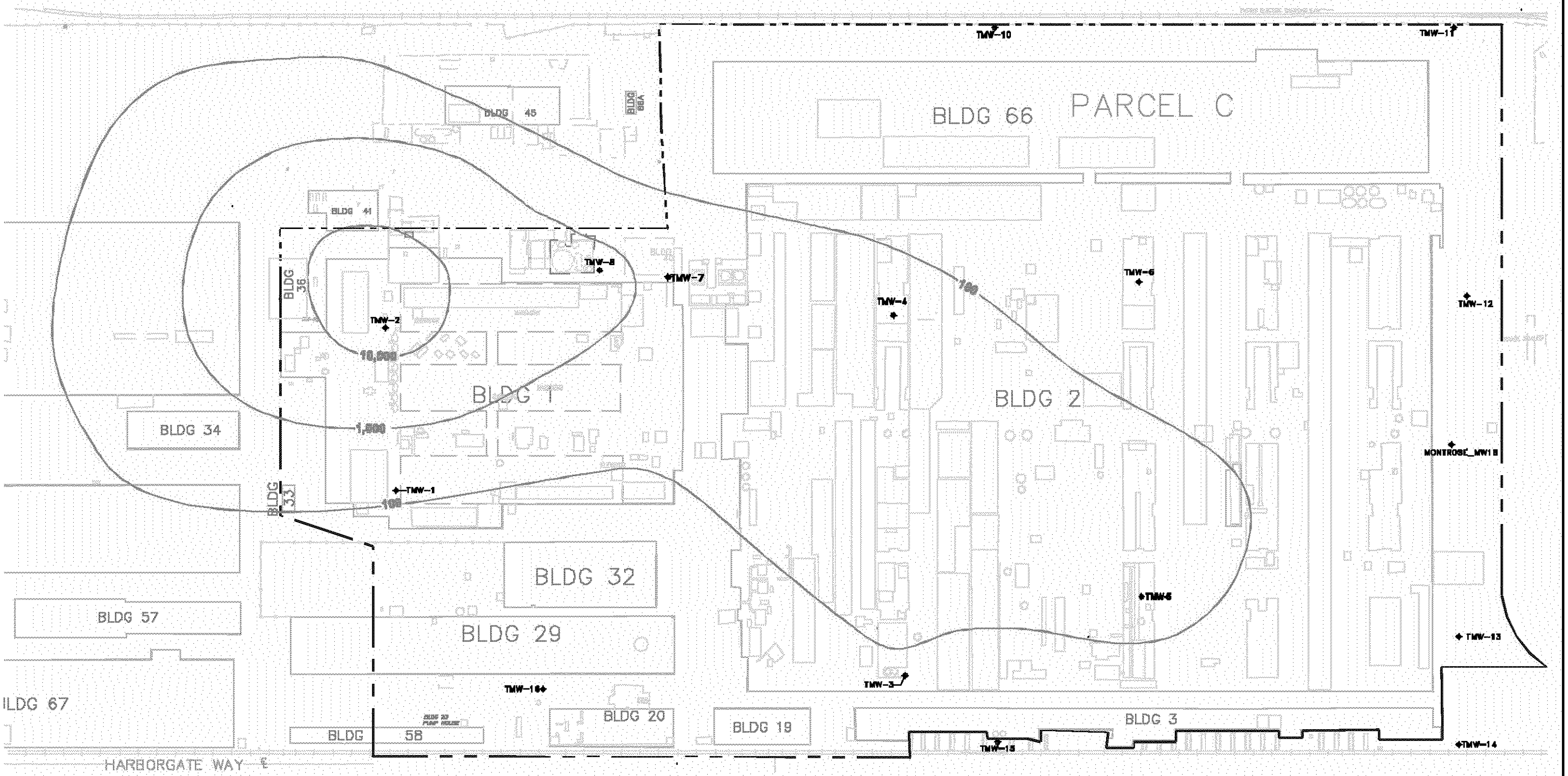
FIGURE 2

TCE DISTRIBUTION IN GROUNDWATER JANUARY/FEBRUARY 2001

FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

PREPARED FOR
BOEING REALTY CORPORATION
LONG BEACH, CALIFORNIA

HALEY & ALDRICH
ENGLAND GEOSYSTEM
ENVIRONMENTAL ENGINEERING



LEGEND

TMW-9 ◆ GROUNDWATER MONITORING WELL

100 APPROXIMATE 1,1-DCE ISOCONCENTRATION CONTOURS (ug/l)

PARCEL C BOUNDARY

N

0 40 80 160

FEET

ALL DIMENSIONS AND LOCATIONS ARE APPROXIMATE

SOURCE OF BASEMAP: KENNEDY JENKS CONSULTANTS, 2000, SAMPLING AND ANALYSIS PLAN, BOEING REALTY CORPORATION'S C-6 FACILITY, PARCEL C, LOS ANGELES, CA, AUGUST 16, 2000.
G:\DRAWINGS\APROJECT\BOEING\TORRANCE\1-DCE CONCENTRATIONS IN GROUNDWATER- 20 SEPTEMBER, 2001\FIGURE 29 - 1,1-DCE CONCENTRATIONS IN GROUND WATER

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

BOEING REALTY CORPORATION
FORMER C-6 FACILITY
LOS ANGELES, CALIFORNIA

FIGURE: 3

1,1-DCE CONCENTRATIONS IN GROUNDWATER JANUARY 2001

SCALE: AS SHOWN	QA/QC:	PROJECT: 27285-001
DRAWN: SAL	REVIEWED: RMF	DATE: 20 SEPTEMBER, 2001

5,000 UPPER B-SAND CONTOUR

5,000 C-SAND CONTOUR

5,000 LOWER B-SAND CONTOUR

5,000 LOWER B-SAND CONTOUR

5,000 LOWER B-SAND CONTOUR

BLDG 45

BLDG 66A

BLDG 66

BLDG

BLDG 41

BLDG 36

BLDG 34

BLDG 0

BLDG 1

BLDG 32

EQUIPMENT FOUNDATION (F'26)

SLAB MILLING (57)

BURR & BLEND (56)

AUTO SCREW MACHINES (44)

TOOL GRINDING (42)

SHELL BUILDING (58)

EQUIPMENT FOUNDATION (F'26)

METAL FINISHING

PAINT APPL

CHEMICAL STORAGE

CHEMICAL STORAGE

FUEL S

AR

DDS-1-1

DDS-1-2

DDS-1-3

DDS-1-4
2500

DDS-1-5
11,000

DDS-1-6
840

DDS-1-7
6000

DDS-1-8

DDS-1-9
32,000

DDS-1-10

DDS-1-11
430

DDS-1-12

DDS-1-13

DDS-1-14
30,000

DDS-1-15
6800

DDS-2-3

DDS-2-4
3.3

DDS-2-7

DDS-2-9
4

DDS-2-10
14

DDS-2-19
9.2

DDS-2-20
13

DDS-2-21
1

CPT-1-1

CPT-1-2

CPT-2-2

TMW-1

TMW-2

TMW-4

TMW-7

TMW-9

RW-1

WWC-03S

WWC-03D

WWC-04S

WWC-06S

WWC-07S

WWC-12S

5,000

10,000

5,000

10,000

5,000

A

(REFER TO FIGURE 9 FOR CROSS SECTION)

KNOX ST.

AREA 1-1

BUILDING 1/36
VOC'S GROUNDWATER IMPACTS

FORMER BOEING C-6 FACILITY
LOS ANGELES CALIFORNIA

FIGURE: 4

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

ARCADIS

SCALE: AS SHOWN

DRAWN: SAL | REVIEWED: JKN | DATE: 13 MAR., 2002

PROJECT: CA000594

LEGEND

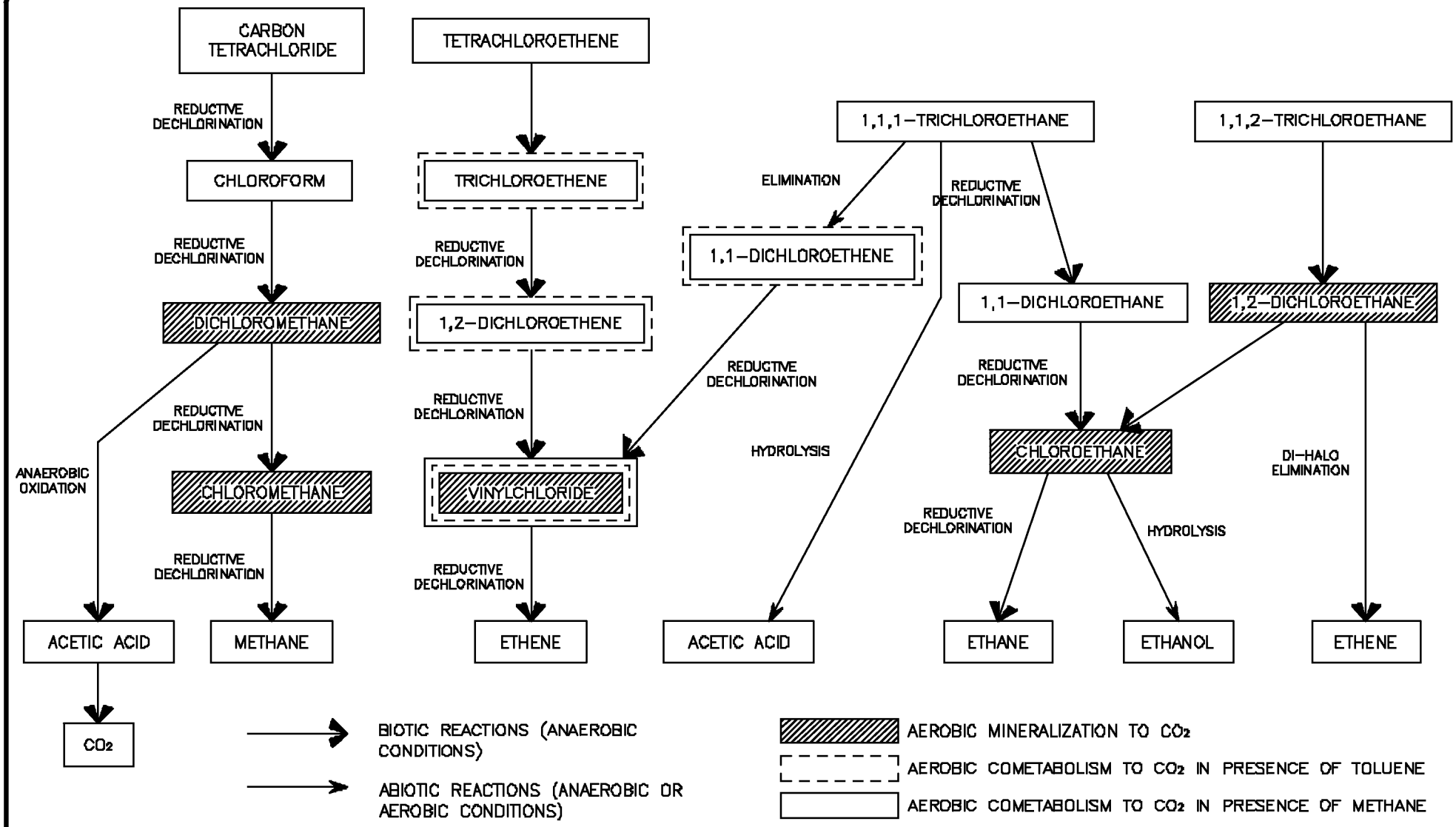
TMW-2	UPPER B-SAND EXISTING GROUNDWATER MONITORING WELL
DDS-2-6	DIRECT-PUSH MULTI-DEPTH SIMULPROBE GROUNDWATER GRAB SAMPLE
WWG	WCC UPPER B-SAND AND C-SAND EXISTING GROUNDWATER MONITORING WELL
	VOC'S ISOPLETH FOR UPPER B-SAND
	VOC'S ISOPLETH FOR LOWER B-SAND
	VOC'S ISOPLETH FOR C-SAND

N

0 25 50 100
FEET

SOURCE BASEMAP PROVIDED BY BOEING IN NOVEMBER 1999.
TETRA TECH INC. EA/CH/MS

G:\DRAWINGS\APPROJECTS\BOEING\TORRANCE\BLDG-1-36-REV5



SOURCE: INTERSTATE TECHNOLOGY AND REGULATORY COOPERATION WORK GROUP (ITRC), MAY 1999, NATURAL ATTENUATION OF CHLORINATED SOLVENTS IN GROUNDWATER: PRINCIPLES AND PRACTICES, WWW.ITRCWEB.ORG

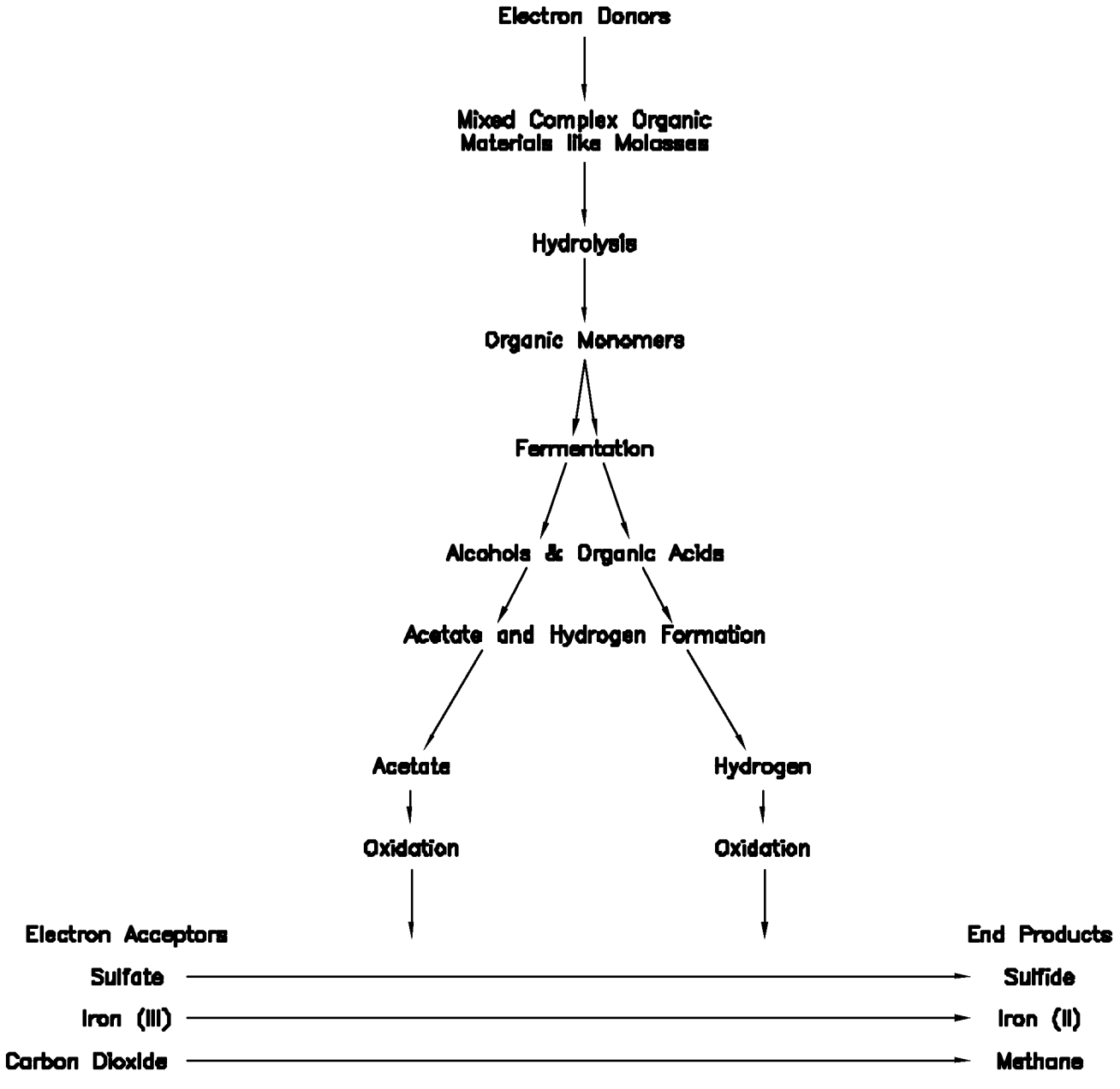
ARCADIS

COMMON DEGRADATION PATHWAYS

BOEING REALTY CORPORATION,
FORMER C-6 FACILITY (BUILDING 1/36 AREA)
LOS ANGELES, CALIFORNIA

FIGURE

5



ARCADIS

CYCLING OF ORGANIC CARBON IN AN IRZ

BOEING REALTY CORPORATION,
FORMER C-6 FACILITY (BUILDING 1/36 AREA)
LOS ANGELES, CALIFORNIA

FIGURE

6

DATE: 12/05/2001 | 12:14 | PRJ#: CA 584.01.01 | DWG: drawings\aproject\boeing\BOE-COCIRZ | FILE: 01-6576 | CHK: BURDICK | PM: LENZO | ART: STILES

5,000 UPPER B-SAND CONTOUR

5,000 C-SAND CONTOUR

ESTIMATED DIAMETER OF INFLUENCE

5,000 LOWER B-SAND CONTOUR

5,000 LOWER B-SAND CONTOUR

5,000 LOWER B-SAND CONTOUR

BLDG 45

BLDG 66A

BLDG 66

BLDG 4

BLDG 1

BLDG 34

BLDG

KNOX ST

EQUIPMENT FOUNDATION (F'26)

SLAB MILLING (57)

BURR & BLEND (56)

AUTO SCREW MACHINES (44)

TOOL GRINDING (42)

PAINT BOOTH (PB)

PAINT APPR

CHEMICAL STORAGE

METAL FINISHING

CHEMICAL STORAGE

BASEMENT

ELEVATOR

MW0001

MW0002

MW0003

MW0004

MW0005

MW0006

MW0007

TMW-1

TMW-2

TMW-4

TMW-7

TMW-9

WCC-04S

WCC-07S

WCC-12S

LEGEND

- 21B — UPPER B-SAND IRZ AMENDMENT POINT, AW0### (PROPOSED)
- 21B — LOWER B-SAND IRZ AMENDMENT POINT, AW0### (PROPOSED)
- 21B — C-SAND IRZ AMENDMENT POINT, AW0### (PROPOSED)
- 21B — UPPER B-SAND AND C-SAND IRZ AMENDMENT POINT, AW0### (PROPOSED)
- 21B — UPPER AND LOWER B-SAND IRZ AMENDMENT POINT, AW0### (PROPOSED)
- 21B — UPPER AND LOWER B-SAND AND C-SAND IRZ AMENDMENT POINT, AW0### (PROPOSED)
- LOWER B-SAND MONITORING WELL, MW000# (PROPOSED)
- UPPER B-SAND MONITORING WELL, MW000# (PROPOSED)
- C-SAND MONITORING WELL, MW000# (PROPOSED)
- UPPER AND LOWER B-SAND MONITORING WELL, MW000# (PROPOSED)
- UPPER AND LOWER B-SAND AND C-SAND MONITORING WELL, MW000# (PROPOSED)
- TMW-2 — EXISTING B-SAND GROUNDWATER MONITORING WELL
- WCC — WCC UPPER B-SAND AND C-SAND EXISTING GROUNDWATER MONITORING WELL
- VOC ISOPLETH FOR B-SAND
- VOC ISOPLETH FOR B-SAND BOTTOM
- VOC ISOPLETH FOR C-SAND

N

0 25 50 100

FEET

SOURCE BASEMAP PROVIDED BY BOEING IN NOVEMBER 1999. TETRA TECH NUS, INC. 12/28/99

G:\DRAWINGS\APROJECTS\BOEING\TORRANCE\IRZ-DESIGN-B-BB-C-REV5

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

ARCADIS

FORMER BOEING C-6 FACILITY
LOS ANGELES CALIFORNIA

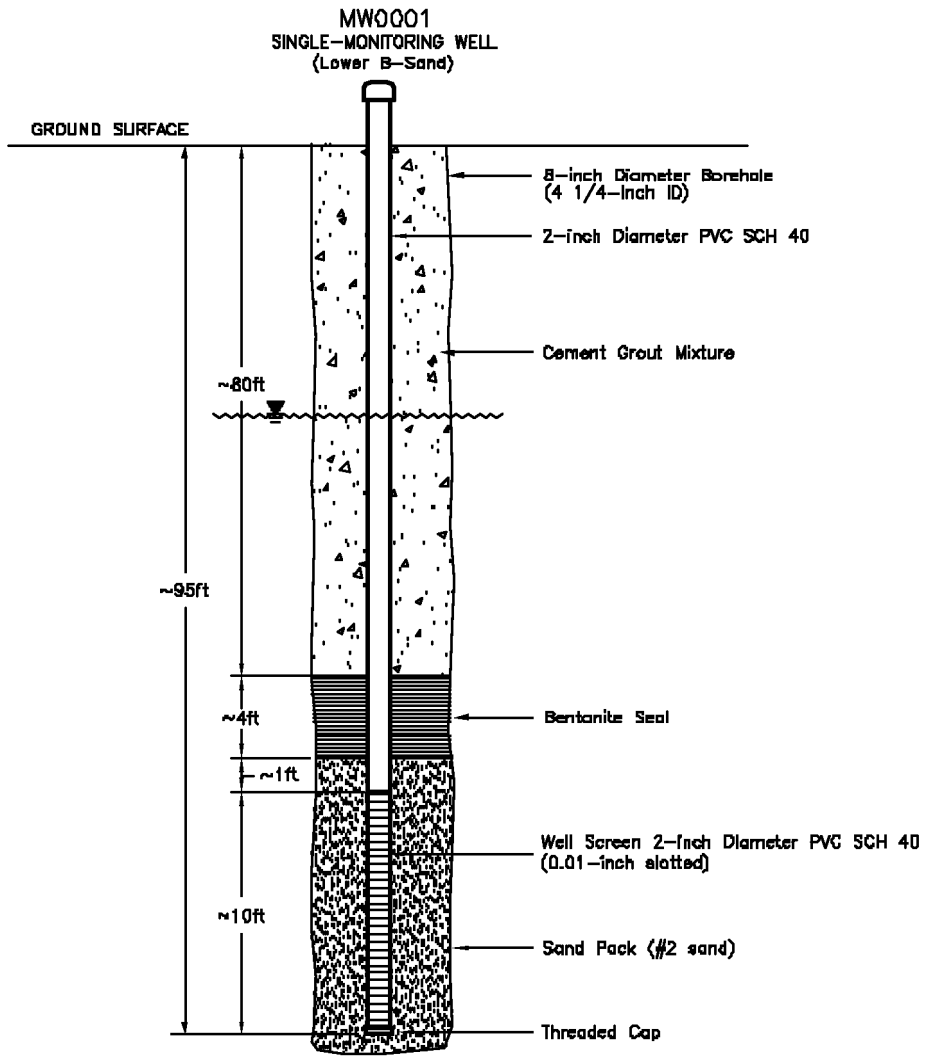
FIGURE: 7

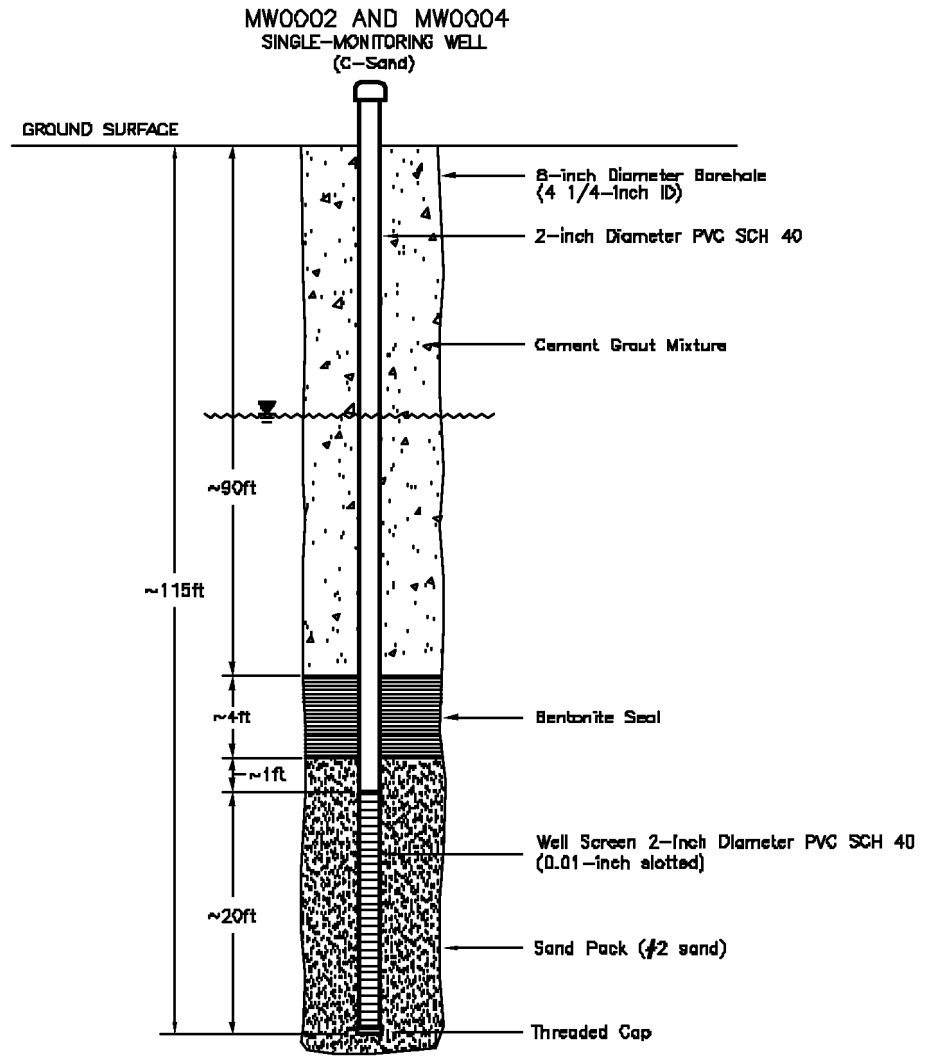
BUILDING 1/36
PROPOSED IRZ AMENDMENT POINTS AND MONITORING WELL LAYOUT

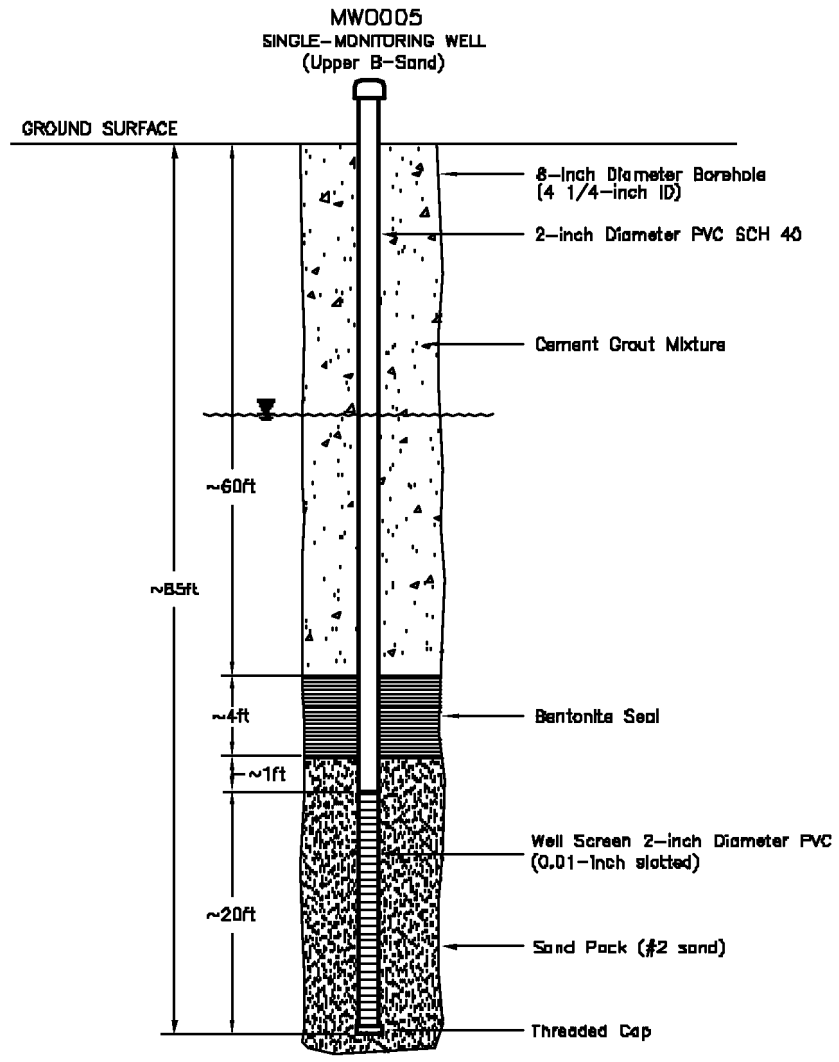
SCALE: AS SHOWN

PROJECT: CA000594

DRAWN: SAL | REVIEWED: JKN | DATE: 19 DEC., 2001







LEGEND

PVC	POLYVINYL CHLORIDE
SCH	SCHEDULE
ft	FEET

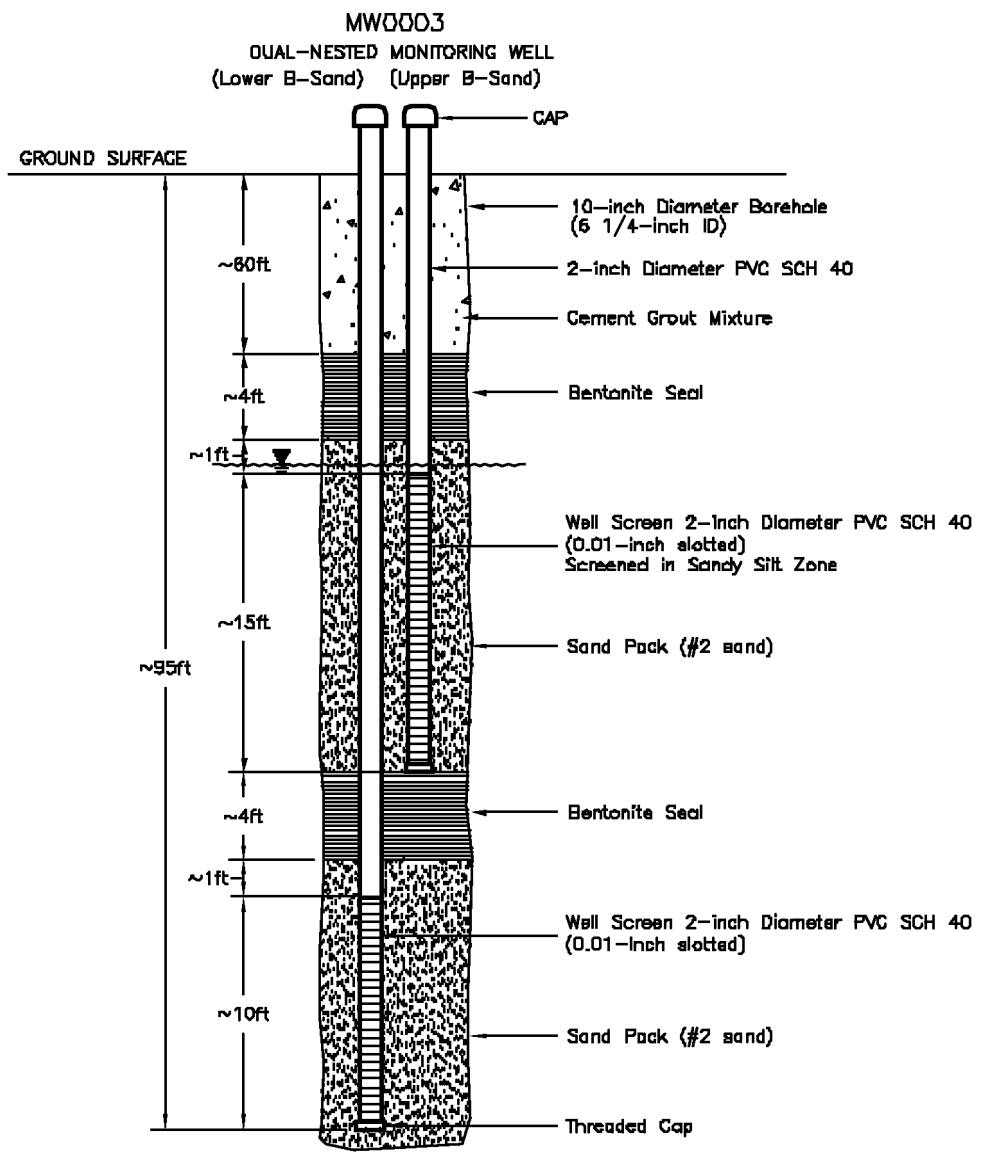
NOT TO SCALE

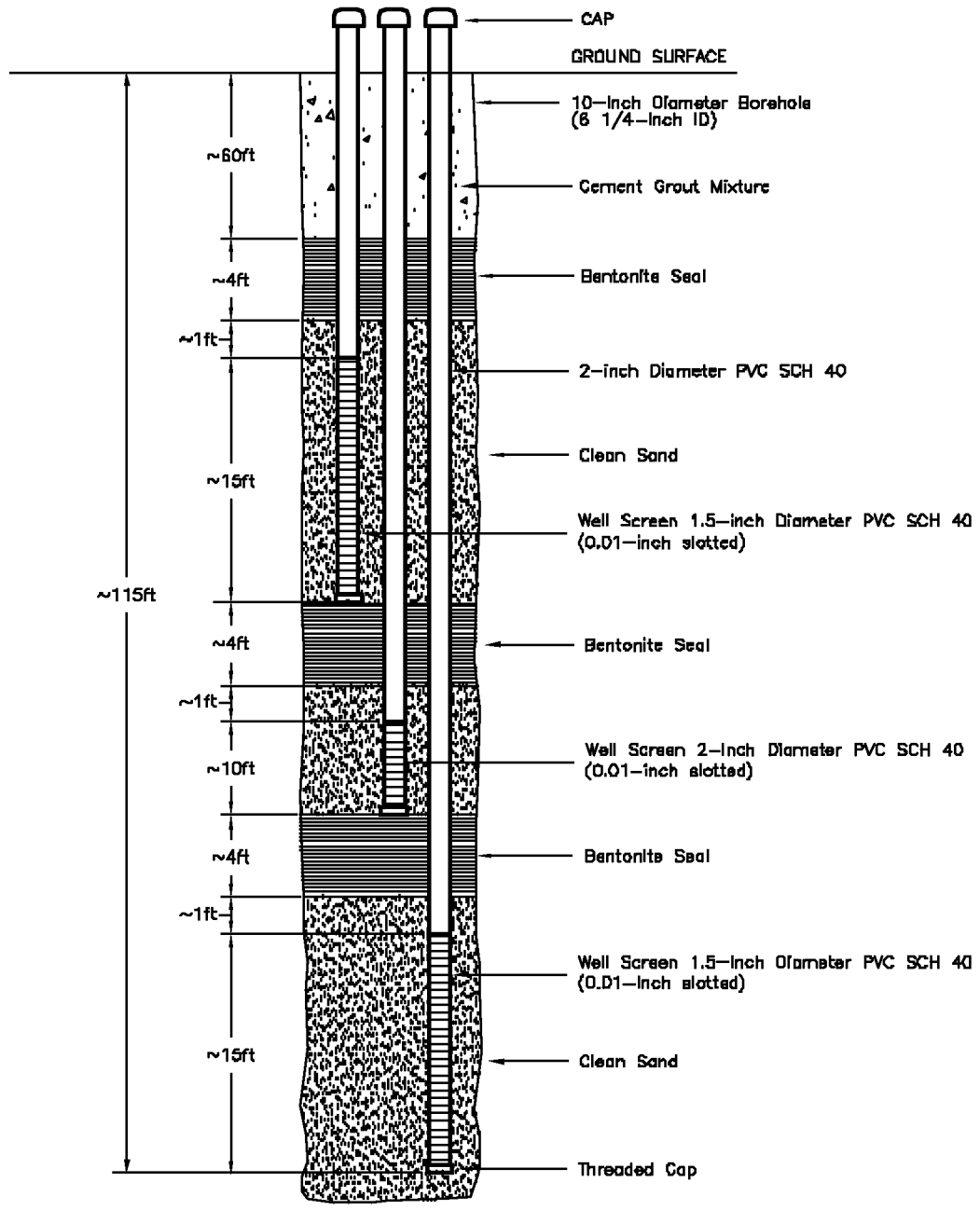
ARCADIS

TYPICAL CONSTRUCTION DETAILS FOR SINGLE IRZ MONITORING WELLS

BOEING REALTY CORPORATION
FORMER C-6 FACILITY (BUILDING 1/36 AREA)
LOS ANGELES, CALIFORNIA

FIGURE
8A





LEGEND
PVC POLYVINYL CHLORIDE
SCH SCHEDULE
ft FEET

NOT TO SCALE

ARCADIS

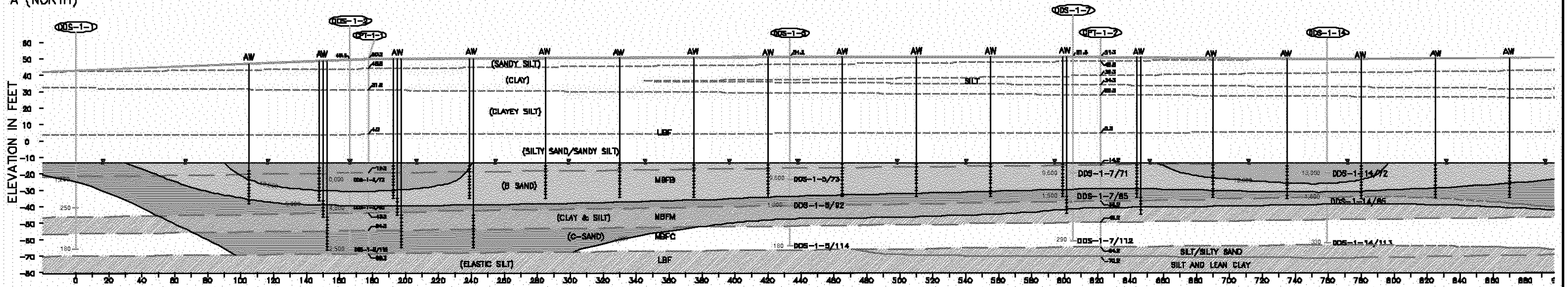
TYPICAL CONSTRUCTION DETAILS FOR DUAL AND NESTED IRZ MONITORING WELLS

BOEING REALTY CORPORATION
FORMER C-6 FACILITY (BUILDING 1/36 AREA)
LOS ANGELES, CALIFORNIA

FIGURE
8B

CPT-1 AREA

A (NORTH)



LEGEND

- 0–1,000 ug/L TCE
- 1,001–5,000 ug/L TCE
- 5,001–10,000 ug/L TCE
- 10,001 + ug/L TCE
- CLAY

0 15 30 60

APPROXIMATE SCALE: 1" = 60'-0"

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

BOEING REALTY CORPORATION
FORMER BOEING C-6 FACILITY
LOS ANGELES, CALIFORNIA

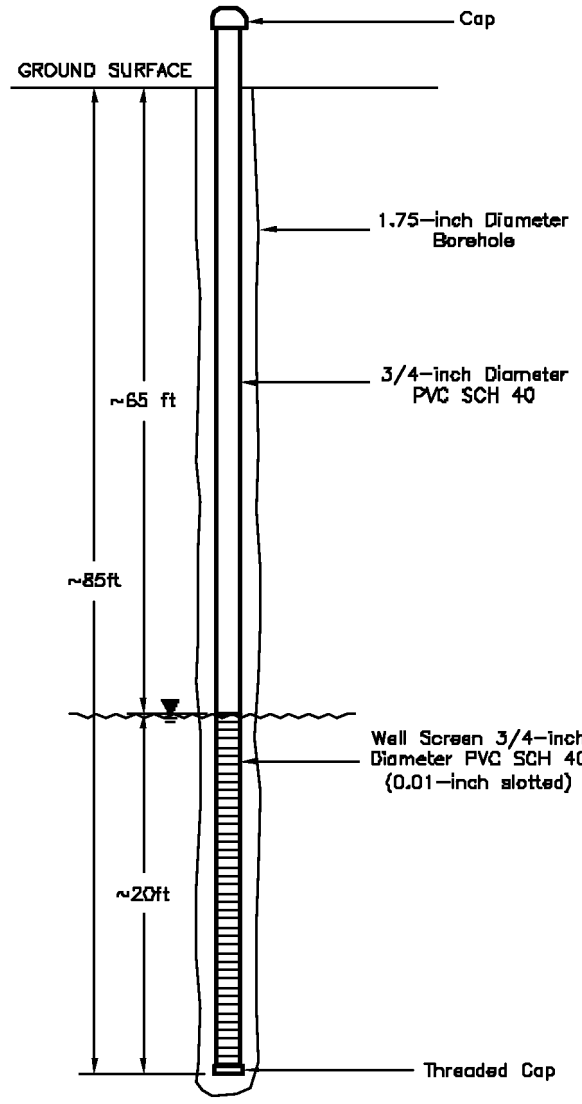
FIGURE: 9

CROSS SECTION
WITH IRZ AMENDMENT
POINTS

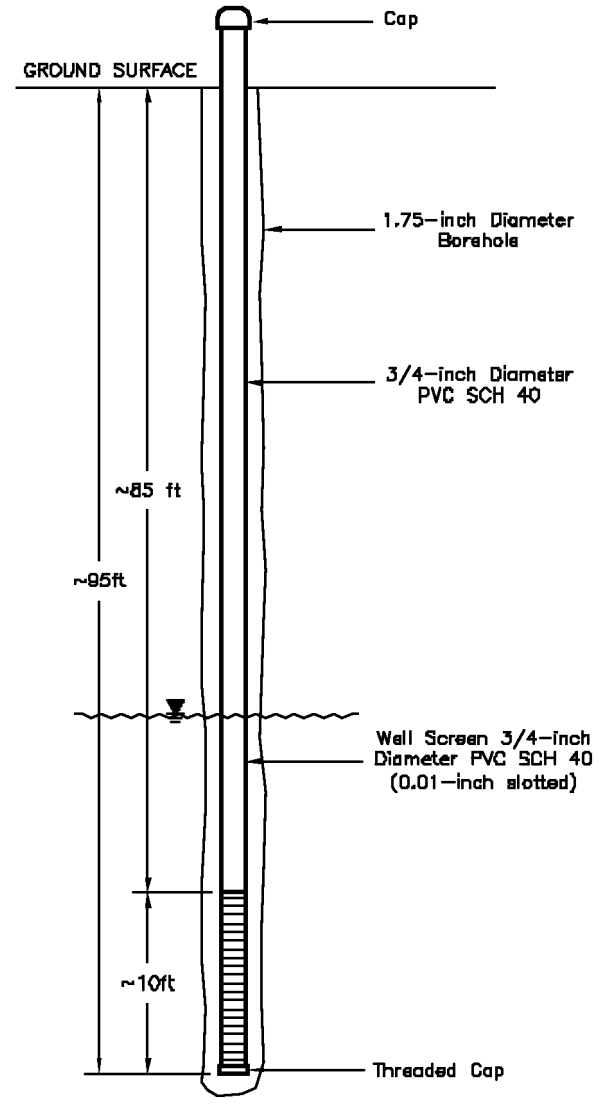
SCALE 1"=40' | PROJECT: 27936
DRAWN: SAL | REVIEWED: RLM | DATE: 24 OCT. 2001

G:\DRAWINGS\APROJECT\BOEING\TORRANCE\CROSS SECTION A-A' CPT1 AREA REV3

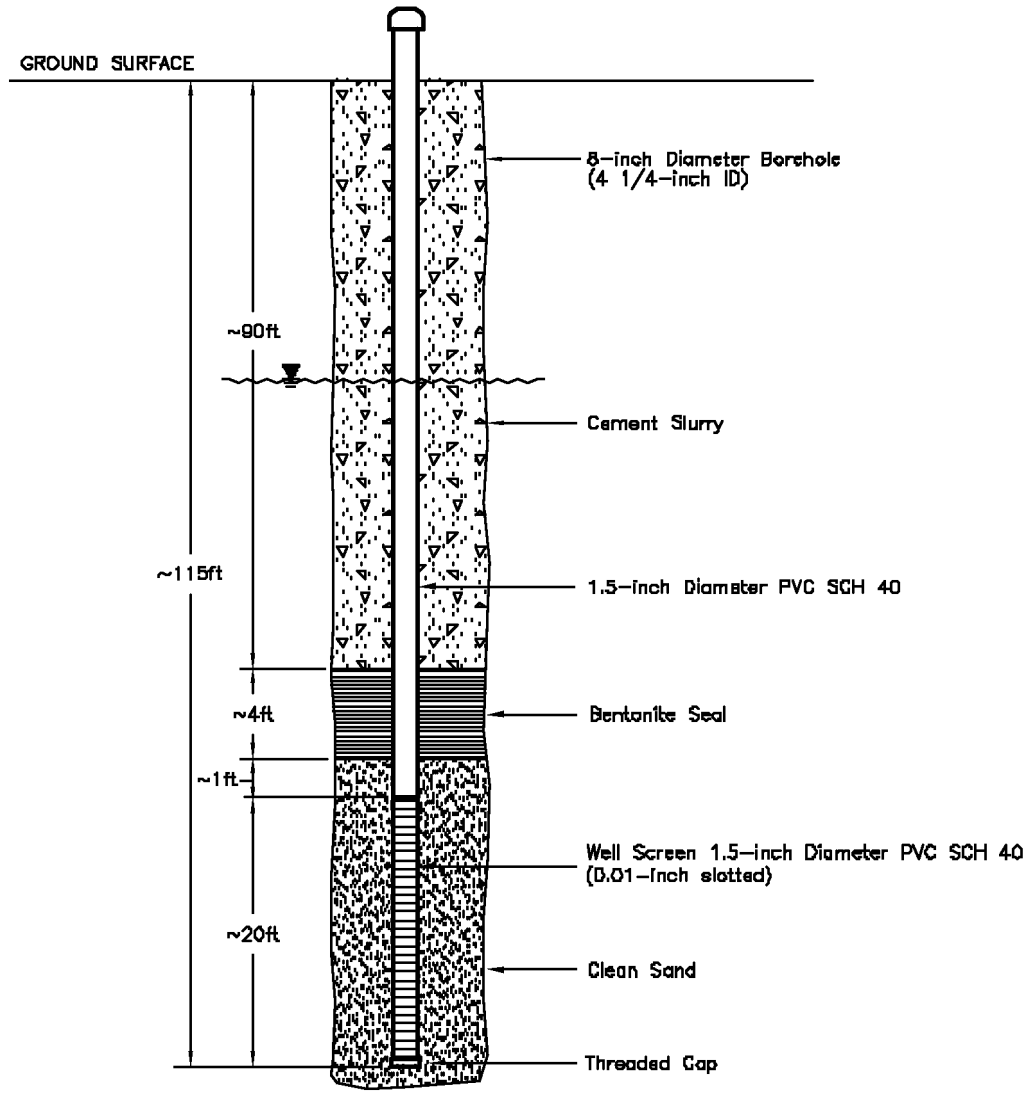
SINGLE IRZ
AMENDMENT POINT
(Upper B-Sand)



SINGLE IRZ
AMENDMENT POINT
(Lower B-Sand)



SINGLE IRZ
AMENDMENT POINT
(C-Sand)



LEGEND

PVC	POLYVINYL CHLORIDE
SCH	SCHEDULE
ft	FEET

NOT TO SCALE

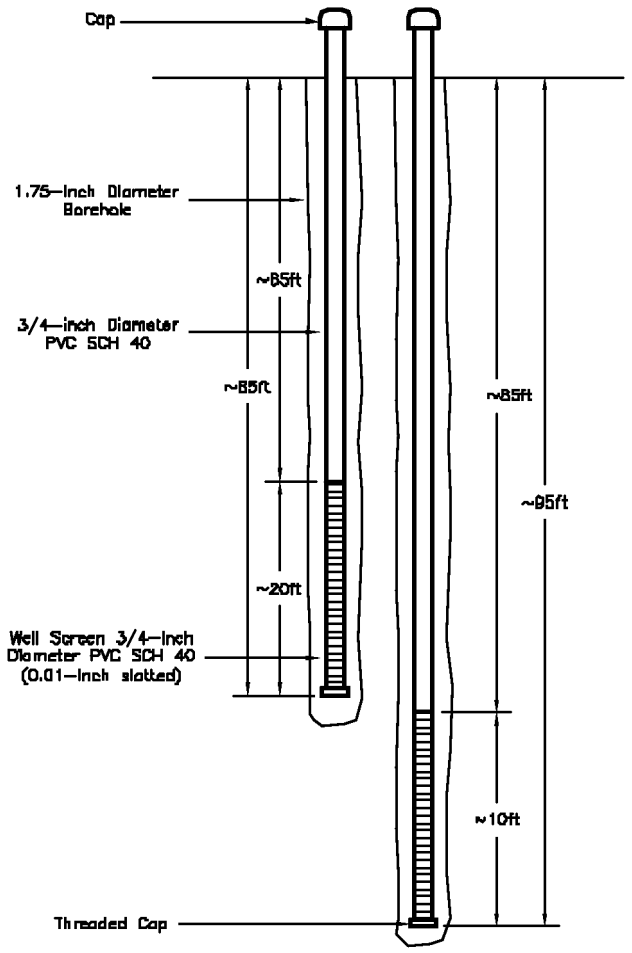
ARCADIS

TYPICAL CONSTRUCTION DETAILS
SINGLE IRZ AMENDMENT POINTS

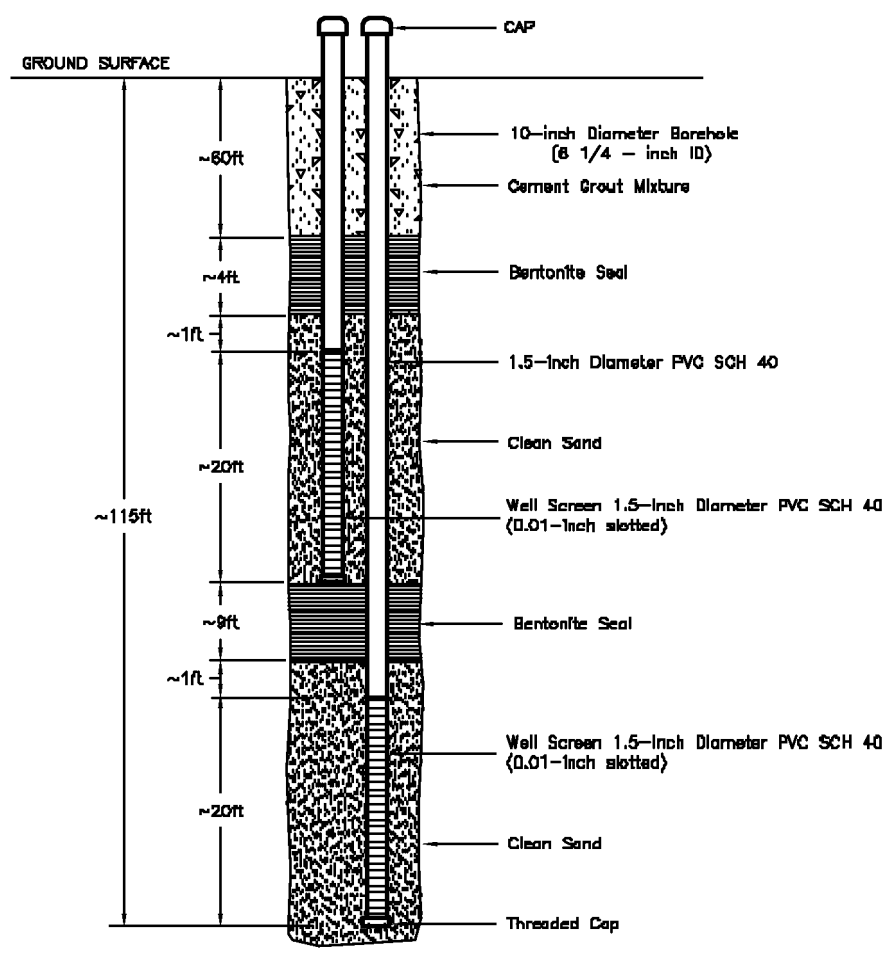
BOEING REALTY CORPORATION
FORMER C-6 FACILITY (BUILDING 1/36 AREA)
LOS ANGELES, CALIFORNIA

FIGURE
10A

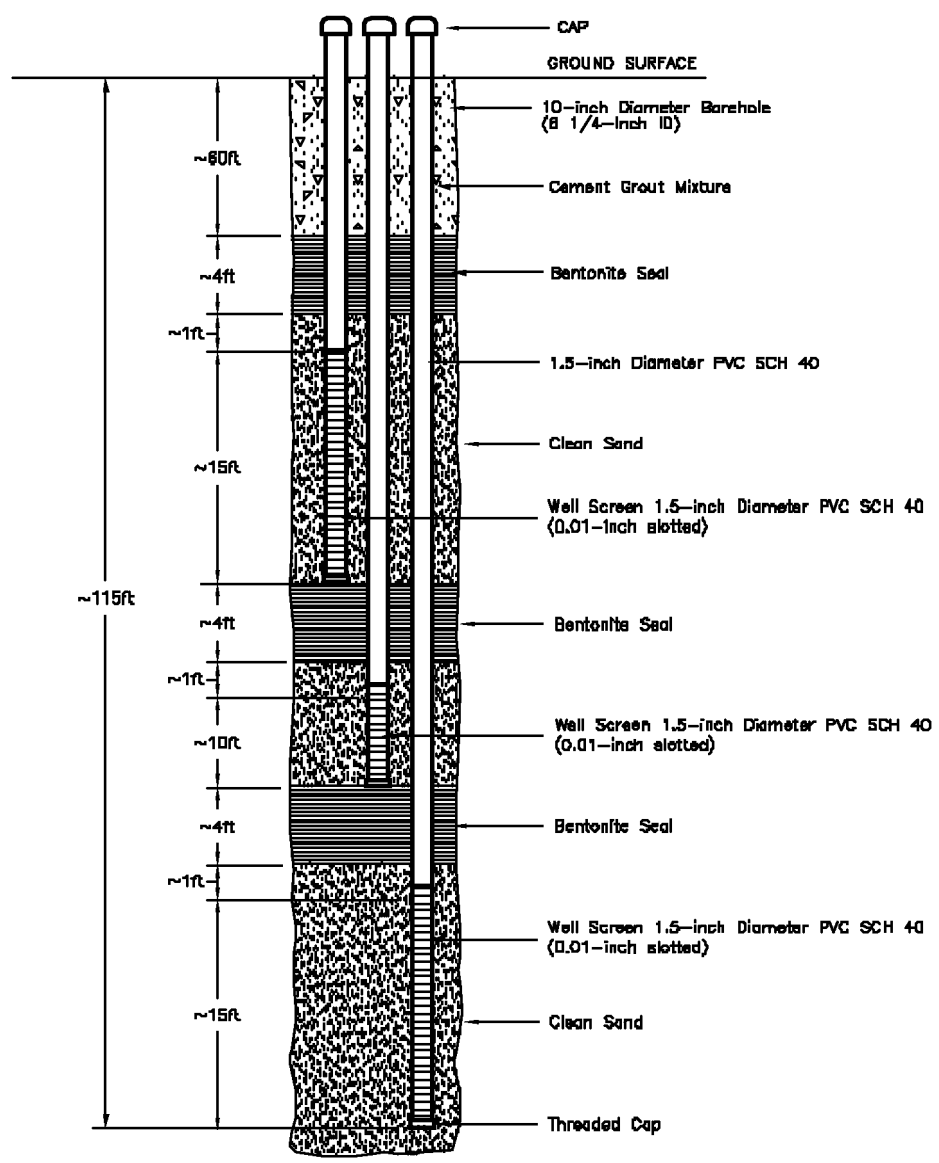
DUAL IRZ
AMENDMENT POINTS
(Upper and Lower B-Sand)



DUAL-NESTED IRZ
AMENDMENT POINT
(Upper B-Sand and C-Sand)



TRIPLE-NESTED IRZ
AMENDMENT POINT
(Upper and Lower B-Sand and C-Sand)



LEGEND

PVC	POLYVINYL CHLORIDE
SCH	SCHEDULE
ft	FEET

NOT TO SCALE

ARCADIS

TYPICAL CONSTRUCTION DETAILS
DUAL AND NESTED IRZ AMENDMENT POINTS
BOEING REALTY CORPORATION
FORMER C-6 FACILITY (BUILDING 1/36 AREA)
LOS ANGELES, CALIFORNIA

FIGURE
10B

Appendix A

Material Safety Data Sheets

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB. No. 1218-0072

IDENTITY (As Used, on Label and List) -	Note: Blank spaces are not permitted. If any item is not applicable or no information is available, the space must be marked to indicate that.
CODE #677 MOLASSES	

Section I

Manufacturer's Name	Emergency Telephone Number
INTERNATIONAL MOLASSES CORP., LTD.	201-368-8036
Address (Number, Street, City, State and ZIP code)	**Telephone Number for Information**
P.O. BOX 67	800-526-0180
	Date Prepared
SADDLE BROOK, NJ	
	Signature of Preparer (optional)
07662	

Section II - Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity: Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Not Applicable				

Section III - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H20 = 1)	N/A
Vapor Pressure (mm Hg.)	N/A	Melting Point	N/A
Vapor Density (AIR = 1)	N/A	Evaporation Rate (Butyl Acetate = 1)	N/A

Solubility in Water
99%

Appearance and Odor
BROWN LIQUID, MOLASSES ODOR

SECTION IV - Fire and Expansion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
NOT APPLICABLE	NOT APPLICABLE		

Extinguishing Media
WATER

Special Fire Fighting Procedures
NONE

Unusual Fire and Explosion Hazards
NONE

GRANULAR WHEY

PRODUCT DESCRIPTION: Granular Whey is a free-flowing, non-hygroscopic sweet whey, produced exclusively by International Ingredient Corporation. The product is dried fresh in the cheese manufacturing facility using a unique roller drying process. Because the whey is dried immediately when fresh, neutralizing agents and bleaches, commonly used in other whey drying processes, are not used. The light cream color of Granular Whey comes from the natural cheese color. The unique drying process also "fixes" lactose in the ß-form, the sweetest form of lactose. The nutritional profile and uniformity of Granular Whey is superior to that of spray-dried whey.

TYPICAL ANALYSIS	
Crude Protein	12.5%
Crude Fat	1.0%
Crude Fiber	0.0%
Lactose	72.0%
Lysine	1.0%
Ash	7.5%
Salt	2.5%
Moisture	4.0%
M.E. (calculated)	1,628 kcal/kg

PHYSICAL PROPERTIES:

Color:	Cream to orange cheddar color
Aroma:	Mild characteristic milk aroma
Flavor:	Sweet, (ß-form of lactose)
Texture:	Granular
Bulk Density:	40-45 lb./cu. ft (~5.35 lb/gal)
Salmonella:	Negative

USAGE: Granular Whey is the ideal whey for dry feed and pet food applications. Usage levels generally range between 5-30% of the diet, depending on the age and weight of the animal. The granular texture provides unique benefits where product flowability is critical, such as in hot, humid environments.

PACKAGING: Fifty pound, multiwalled, polylined, paper bags or bulk.

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 202-483-7616

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

POTASSIUM BROMIDE

1. Product Identification

Synonyms: Bromide salt of potassium
CAS No: 7758-02-3
Molecular Weight: 119.00
Chemical Formula: KBr
Product Codes: **J.T. Baker:**
2961, 2998
Mallinckrodt:
0493, 0500, 0505

2. Composition/Information on Ingredients

Ingredient	CAS No.	Percent	Hazardous
Potassium Bromide	7758-02-3	100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. AFFECTS CENTRAL NERVOUS SYSTEM, BRAIN AND EYES. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings

(Provided here for your convenience)

Health:	Flammability:	Reactivity:	Contact:
1 - Slight	0 - None	0 - None	1 - Slight

Lab Protection Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:

Dust may cause irritation to the respiratory tract. Symptoms may include coughing, sore throat, and shortness of breath.

Ingestion:

May cause nausea, vomiting and abdominal pain. Ingestions are usually promptly rejected by vomiting, but sufficient absorption may occur to produce central nervous system, eye and brain effects. Symptoms may include skin rash, blurred vision and other eye effects, drowsiness, irritability, dizziness, mania, hallucinations, and coma.

Skin Contact:

Dry material may cause mild irritation. Solutions may cause irritation, redness, pain, and skin burns.

Eye Contact:

May cause irritation, redness and pain.

Chronic Exposure:

Repeated or prolonged exposure by any route may cause skin rashes (bromaderma). Repeated ingestion of small amounts may cause central nervous system depression, including depression, ataxia, psychoses, memory loss, irritability, and headache.

Aggravation of Pre-existing Conditions:

Persons suffering from debilitation, depression, alcoholism, neurological or psychological disorders may be more susceptible to the effects of this compound.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Call a physician.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. Call a physician.

Eye Contact:

Wash eyes with plenty of water for at least 15 minutes. Call a physician.

5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard.

Explosion:

Not considered to be an explosion hazard.

Fire Extinguishing Media:

Use any means suitable for extinguishing surrounding fire.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Separate from incompatibilities. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

None established.

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", most recent edition, for details.

Personal Respirator (NIOSH Approved)

For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White crystals.

Odor:
Odorless.

Solubility:
70g/100g water @ 25°C (77°F).

Specific Gravity:
2.75 @ 25°C

pH:
Aqueous solution is neutral.

% Volatiles by volume @ 21°C (70°F):
0

Boiling Point:
1435°C (2615°F)

Melting Point:
730°C (1346°F)

Vapor Density (Air=1):
No information found.

Vapor Pressure (mm Hg):
No information found.

Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Oxides of the contained metal and halogen, possibly also free, or ionic halogen.

Hazardous Polymerization:

Will not occur.

Incompatabilities:

For Potassium Bromide: Strong oxidizers, acids, and bromine trifluoride.

Conditions to Avoid:

Incompatibles.

11. Toxicological Information

Potassium bromide: oral rat LD50: 3070 mg/kg; investigated as a mutagen.

Cancer Lists

Ingredient	—NTP Carcinogen— Known	Anticipated	IARC Category
Potassium Bromide (7758-02-3)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations.

Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

Chemical Inventory Status

Ingredient	TSCA	EC	Japan	Australia	Korea	—Canada— DSL	NDSL	PhIL
Potassium Bromide (7758-02-3)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

Federal, State & International Regulations

Ingredient	—SARA 302— RQ	TPQ	—SARA 313— List	Chemical Catg.	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Potassium Bromide (7758-02-3)	No	No	No	No	No	No	No

Chemical Weapons Convention: No **TSCA 12(b):** No **CDTA:** No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No Reactivity: No (Pure / Solid)
Warning:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: No information found. **Australian Poison Schedule:** No information found.
WHMIS: This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings:
Health: 2 Flammability: 0 Reactivity: 0
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED OR INHALED. AFFECTS CENTRAL NERVOUS SYSTEM, BRAIN AND EYES. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.
Label Precautions:
Avoid breathing dust.

Keep container closed.
Use with adequate ventilation.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. In all cases call a physician.

Product Use:

Laboratory Reagent.

Revision Information:

New 16 section MSDS format, all sections have been revised.

Disclaimer:

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Prepared By: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

Sodium Bicarbonate

**** MATERIAL SAFETY DATA SHEET ****

Sodium Bicarbonate
20970

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Sodium Bicarbonate
Catalog Numbers:
BP328 1, BP328 500, BP328-1, BP328-500, BW13501300, BW1350150, BW1350350, S233 10, S233 3, S233 50, S233 500, S233-10, S233-3, S233-50, S233-500, S233300LB, S631 10, S631 3, S631 50, S631-10, S631-3, S631-50, S631-500, S71986, S71986-1, S78284, S78284-1
Synonyms:
Baking soda, sodium acid carbonate, sodium hydrogen carbonate, monosodium carbonate, bicarbonate of soda
Company Identification: Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
144-55-8	Sodium bicarbonate	100	unlisted

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW
Appearance: White crystalline powder or granules. Flash Point: .0 C.
CAUTION! MAY CAUSE EYE AND SKIN IRRITATION. MAY CAUSE RESPIRATORY AND DIGESTIVE TRACT IRRITATION.
Target Organs: None.

Potential Health Effects
Eye:
May cause eye irritation.
Skin:
May cause skin irritation.
Ingestion:
May cause irritation of the digestive tract.

Inhalation:
Causes respiratory tract irritation.
Chronic:
Prolonged or repeated skin contact may cause irritation.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid.
Skin:
Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse.
Ingestion:
If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid.
Inhalation:
Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid if cough or other symptoms appear.
Notes to Physician:
None
None reported.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Material will not burn.
Extinguishing Media:
For small fires, use water spray, dry chemical, carbon dioxide or chemical foam.
Autoignition Temperature: .0_C (32.00_F)
Flash Point: .0_C (32.00_F)
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Wash thoroughly after handling. Minimize dust generation and accumulation. Avoid prolonged or repeated contact with skin. Avoid breathing vapors from heated material.
Storage:
Store in a cool, dry, well-ventilated area away from incompatible substances.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Good general ventilation should be sufficient to control airborne levels.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Sodium bicarbonate	none listed	none listed	none listed

OSHA Vacated PELs:
Sodium bicarbonate:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear safety glasses with side shields.
Skin:
Wear appropriate gloves to prevent skin exposure.
Clothing:
Wear appropriate protective clothing to minimize contact with skin.
Respirators:
A NIOSH/MSHA approved air purifying dust or mist respirator.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State: Solid
Appearance: White crystalline powder or granules.
Odor: Odorless
pH: 8.3 (0.1M solution)
Vapor Pressure: Not available.
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: Not available.
Freezing/Melting Point: 270_F
Decomposition Temperature: Not available.
Solubility: Soluble in water

Specific Gravity/Density: 2.16
Molecular Formula: NaHCO3
Molecular Weight: 83.995

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable.
Conditions to Avoid:
Incompatible materials.
Incompatibilities with Other Materials:
Reacts dangerously with monoammonium phosphate or a sodium-potassium alloy. Decomposes by reaction with acids.
Hazardous Decomposition Products:
Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 144-55-8: VZ0950000
LD50/LC50:
CAS# 144-55-8: Oral, mouse: LD50 = 3360 mg/kg; Oral, rat: LD50 = 4220 mg/kg.
Carcinogenicity:
Sodium bicarbonate -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
None reported
Teratogenicity:
Experimental teratogen
Reproductive Effects:
None reported
Neurotoxicity:
No information reported
Mutagenicity:
Mutation data reported
Other Studies:
None reported

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
This chemical has no biological oxygen demand and will not directly or indirectly cause oxygen depletion in aquatic organisms. It has a low potential to affect aquatic organisms. Acute aquatic effects: 24-hour LC50; Mosquito fish: 7700 mg/L 48-hour LC50; Mosquito fish: 7550 mg/L 96-hour LC50; Bluegill sunfish: 8250-9000 mg/L Immobilization threshold; Water flea: 2350-4200 mg/L
Environmental Fate:
This chemical released into the environment is not expected to have a

significant impact.
Physical/Chemical:
None reported.
Other:
None reported.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
No information available
IMO
Not regulated as a hazardous material.
IATA
Not regulated as a hazardous material.
RID/ADR
Not regulated as a hazardous material.
Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

A. Federal
TSCA
CAS# 144-55-8 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
CERCLA/SARA
Section 302 (RQ)
None of the chemicals in this material have an RQ.
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
Section 313
No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.

This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
B. State
Not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level:
None of the chemicals in this product are listed.
C. International
Canada
CAS# 144-55-8 is listed on Canada's DSL/NDSL List.
CAS# 144-55-8 is not listed on Canada's Ingredient Disclosure List.
European Labeling in Accordance with EC Directives
Hazard Symbols: Not available.
Risk Phrases:
Safety Phrases:
Exposure Limits:
OEL-AUSTRALIA:TWA 0.1 ppm (0.3 mg/m3). OEL-BELGIUM:STEL 0.11 ppm (0.3 mg/m3). OEL-DENMARK:TWA 0.3 mg/m3. OEL-FINLAND:TWA 0.1 ppm (0.3 mg/m3) ;STEL 0.3 ppm (0.9 mg/m3). OEL-FRANCE:STEL 0.1 ppm (0.3 mg/m3). OEL-GE RMANY:TWA 0.07 ppm (0.2 mg/m3). OEL-THE NETHERLANDS:TWA 0.1 ppm (0.3 m g/m3). OEL-SWITZERLAND:TWA 0.07 ppm (0.2 mg/m3). OEL-UNITED KINGDOM:TW A 0.1 ppm (0.3 mg/m3);STEL. OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA c heck ACGIH TLV. OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

**** SECTION 16 - ADDITIONAL INFORMATION ****

Additional Information:
Added NFPA codes to Section 5. Added SARA classifications to Section 15.
Section 3, Emer Overview, added "CAUTION!..".
Section 3, Emer Overview, added "MAY CAUSE EYE AND SKIN IRRITATION...".
Section 3, Emer Overview, added "MAY CAUSE RESPIRATORY AND DIGESTIVE..".
Section 3, Eye Effects, added "May cause eye irritation...".
Section 3, Skin Effects, added "May cause skin irritation...".
Section 3, Inhalation Effects, added "Causes respiratory tract irritation..".
Section 3, Ingestion Effects, added "May cause irritation of the digesti..".
Section 3, Chronic Effects, added "Prolonged or repeated skin contact..".

Section 4, Eye First Aid, added "Flush eyes with plenty of water for..".
Section 4, Eye First Aid, added "Get medical aid...".
Section 4, Skin First Aid, added "Flush skin with plenty of soap and..".
Section 4, Skin First Aid, added "Get medical aid...".
Section 4, Skin First Aid, added "Wash clothing before reuse...".
Section 4, Inhalation First Aid, added "Remove from exposure to fresh air i..".
Section 4, Inhalation First Aid, added "If not breathing, give artificial r..".
Section 4, Inhalation First Aid, added "If breathing is difficult, give oxy..".
Section 4, Inhalation First Aid, added "Get medical aid if cough or other s..".
Section 4, Ingestion First Aid, added "If victim is conscious and alert, g..".
Section 4, Ingestion First Aid, added "Get medical aid...".
Section 5, Extinguishing Media, added "For small fires, use water spray, d..".
Section 5, General Firefighting, added "As in any fire, wear a self-contain..".
Section 5, General Firefighting, added "Material will not burn...".
Section 6, Spills/Leaks, added "Vacuum or sweep up material and pla..".
Section 6, Spills/Leaks, added "Avoid generating dusty conditions...".
Section 7, Handling, added "Wash thoroughly after handling...".
Section 7, Handling, added "Minimize dust generation and accumu..".
Section 7, Handling, added "Avoid prolonged or repeated contact..".
Section 7, Handling, added "Avoid breathing vapors from heated..".
Section 7, Storage, added "Store in a cool, dry, well-ventilat..".
Section 8, Engin. Controls, added "Good general ventilation should be..".
Section 8, Eye Protection, added "Wear safety glasses with side shiel..".
Section 8, Skin Protection, added "Wear appropriate gloves to preven t..".
Section 8, Clothing, added "Wear appropriate protective clothin..".
Section 8, Respirators, added "A NIOSH/MSHA approved air purifying.. ".
Section 9, Physical Properties has changed.
Section 10, Stability, added "Stable...".
Section 10, Condit. to Avoid, added "incompatible materials..".
Section 10, Decomposition Prod., added "carbon monoxide..".
Section 10, Decomposition Prod., added "carbon dioxide..".
Section 10, Incompatibilities has changed.
Section 11, Epidemiology has changed.
Section 11, Neurotoxicity has changed.
Section 11, Teratogenicity has changed.
Section 11, Mutagenicity has changed.

Section 11, Reproductive has changed.
Section 11, Other Info has changed.
Section 12, Ecology Info has changed.
Section 12, Environ. Info has changed.
Section 12, Physical Info has changed.
Section 12, Other Info has changed.
MSDS Creation Date: 12/13/1994 Revision Date: 3/18/1996

MSDS INDEX